Administration Report of the Meteorological Department of the Government of India
1901-02 to 1903-04, 1906-07 to 1910-11
1912-13 to 1918-19 and 1920-21

00134425

BOMBAY BRANCH
OF THE
ROYAL ASIATIC SOCIETY.
TOWN HALL, BOMBAY.

Digitized with financial assistance from

Government of Maharashtra

on 01 February, 2020

00134425

13442

ROYAL ASIATIC SOCIETY OF THE BOMBAY BRANCH OF THE

REPORT

ON

THE ADMINISTRATION

OF

THE METEOROLOGICAL DEPARTMENT

OF

THE GOVERNMENT OF INDIA

IN

1901-1902.

OBSERVATORIES.

The observatories maintained by the Government of India are classified as follows:—

First class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, rainfall and wind direction and velocity, or which take special solar actinometric observations.

Second class.—Observatories at which observations are taken daily at 8 hours and (with a few exceptions) transmitted by weather telegram for inclusion in the India Daily Weather Report, and at which additional observations are recorded at 10 hours and 16 hours.

Third class.—Observatories—

(*a*) at stations where there are telegraph offices, and at which observations are taken daily at 8 hours only, and transmitted by weather telegram for inclusion in the Daily Weather Report;

(*b*) at stations where there are no telegraph offices, and which record observations at 10 hours and 16 hours only, in some cases for inclusion in the Monthly Weather Reviews, and in others to furnish a series of 11 years' observations, for the determination of monthly and daily means for these stations, which shall be comparable with the means already obtained for second class observatories. At a few such stations, chiefly Extra Indian, observations are recorded at 8 hours, only.

Fourth class.—Observatories where the observers receive various amounts from the Special Storm Fund under my control for meteorological observations, chiefly of temperature, wind direction and rainfall, submitted monthly during the year.

2. At the commencement of the year 230 observatories contributed registers of meteorological data, of which 47 were non-departmental, and 183 maintained by the

Government of India. At the end of the year the total number of observatories was 235, of which 49 were non-departmental and 186 maintained by the Government of India.

Of the 186 departmental observatories, 7 were first class, 39 were second class, and 140 third class.

3. The following non-departmental observatories were opened during the year :—

Bahrein (Persian Gulf)	On 1st October 1901.
Sonemarg (Kashmir)	„ 28th November 1901.

4. The following gives the changes in departmental observatories during the year under review :—

(1) A second class observatory was opened at Ootacamund on 21st June 1901.
(2) The observatory at Poona was reduced from second to third class on 1st January 1902.
(3) Third class observatories were opened at Tezpur and Dibrugarh on 1st July 1901.

5. The establishment of observatories at Gauhati, Shillong and Cherra Poonjee, which was sanctioned in May 1899, was practically completed by the end of the year under review and observations were commenced in June 1902. The observatory at Dodabetta, sanctioned in December 1899, was completed by the end of the year under review, and observations will be shortly commenced.

Bilaspur, where sanction was obtained in May 1899 to establish an observatory, was found unsuitable and Pendra was substituted, as better representing the conditions on the plateau separating Katni and Bilaspur. Mr. Dallas visited the Chor in September and selected sites on the Peak at Kalabagh, at an elevation of about 11,400 feet and at Saran about 3,500 feet lower, on the north slope of the hill. Plans and estimates have been prepared, and it is hoped that the observatories at the Chor will be completed and observations begun before the end of the year.

First Class Observatories.

6. The Directors of the Government Observatories of Kodaikanal and Madras, and Bombay, publish separate annual reports which are forwarded through the Department for the information of Government. It has hence been ruled that under present arrangements it is unnecessary to include information relating to the working of these observatories in the Administration Report of the Meteorological Department.

The Alipore Observatory.—This observatory is under the charge of the Second Assistant Meteorological Reporter to the Government of India. It is furnished with a complete set of autographic instruments, including a sunshine recorder, a Kew barograph and thermograph, a Beckley's anemograph, a Dines's pressure tube anemometer, a Beckley's rain gauge and also a Milne's horizontal pendulum Seismograph.

8. The self-registering instruments worked satisfactorily during the past year. The measurements from the traces of the barograph and thermograph have been compared with the eye-readings of the standard barometer, and the dry and wet bulbs in the same manner as in the previous twelve years. The following gives the mean differences for the year 1901 and also for the past twelve years :—

	Period 1889-98.	Period 1899-1901.*	1901.
Mean difference between the standard barometer and barograph during the period or year (*i.e.*, standard barometer *minus* barograph) .	″ +·022	″ +·024	″ +·025
Mean difference between the dry bulb in the thermometer shed and the dry bulb trace of the thermograph (*i.e*, thermograph *minus* shed dry bulb thermometer). . . .	° +0·61	° —0·09	° —0·13
Mean difference between the wet bulb in the thermometer shed and the wet bulb trace of the thermograph (*i.e.*, thermograph *minus* wet bulb thermometer).	° +0·74	° +0·73	° +1·08

* Exposure was slightly changed during this period.

9. All instruments issued by the Meteorological Department are carefully tested at this observatory and their corrections ascertained before they are sent out for use. A larger amount of work in testing instruments than usual was done during the year. Five hundred and five instruments were tested and verified during the year (as compared with 480 tested last year). Fifty-seven instruments were condemned as unfit for issue, or were sent for repair to the Mathematical Instrument Department. Amongst these a small number of thermometers were rejected after testing as unfit for further use.

10. The observatory gives mean Calcutta time to the port and shipping. Three time-balls were dropped at 1 P.M. local mean time during the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' Office and the third at the Kidderpore Docks.

This work was, on the whole, carried out satisfactorily during the year. There were thirteen failures, as compared with the average number ten of the past thirteen years:—

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1901-1902	13	13
1900-1901	15	15
1899-1900	13	13
1898-1899	6	6
Mean of ten years 1888-98	10	10

11. *The Allahabad Observatory.*—This observatory is under the charge of the Meteorological Reporter to the Government of the United Provinces of Agra and Oudh. Observations are taken of a considerable number of instruments, in addition to the ordinary meteorological instruments supplied to all observatories. The following is a statement of these instruments and of the records obtained from them:—

The Beckley's anemograph, the Draper's thermograph and sunshine recorder worked well throughout the year. The records are all tabulated to date.

The Dines's pressure tube anemometer did not give satisfactory tracings during the year, failing to record any but winds of considerable strength. It was sent to Calcutta for repairs.

Regular observations of the nature and movements of clouds were made throughout the year by means of a Duboscq's nephescope.

A continuous record of the barometric pressure throughout the year was obtained by a Richard Freres' open scale barograph. The records (which have all been tabulated) are highly satisfactory.

A Richard Freres' thermograph was in use without a break throughout the year. It gave excellent results as a dry bulb instrument, although its wet bulb record was less satisfactory.

A battery of four solar radiation thermometers, to measure the intensity of the sun's heat, and a grass thermometer to measure terrestrial radiation were in use during the year.

Ground temperatures at the surface, and at depths of one and three feet were recorded at 6h. 14h. and 22h. The temperature at the depth of nine feet was observed at 14h.

12. *The Lahore Observatory.*—No change has been made in the work of this observatory during the year. Besides eye observations of all instruments, recorded seven times daily, automatic records are obtained of pressure, temperature, sunshine, wind and rainfall.

Character of the work of observation at Second and Third Class Observatories.

13. In general the character of the work of the observatories shewed an improvement during the year under review. The work done at 129 of the 161 Meteorological

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

Observatories reporting daily by telegraph to Simla (80 per cent. of the whole) was entirely satisfactory and the observations trustworthy and accurate throughout the year. At the following thirteen observatories (8 per cent. of the whole) the work was very unsatisfactory, *viz.*, Mandalay, Cherat, Thayetmyo, Dibrugarh, Chaman, Rawalpindi, Bijapur, Sirsa, Toungoo, Bhamo, Jhansi, Sibsagar and Taunggyi. At the first two observatories the number of erroneous observations detected during the year exceeded one hundred, and although at most of the other observatories the year's result shewed a slight improvement over the previous years' results, there is still considerable room for improvement, particularly in the Burma observatories, which still are, on the whole, the least satisfactory in this respect.

14. A good test of the carefulness and accuracy of the observers is the correctness of the weather telegrams they forward to Simla. The usual list showing the number of observations rejected, and also the number of telegrams incorrectly prepared, for all departmental observatories and certain other observatories working in connection with the Department which send weather telegrams to the Simla, Calcutta, Bombay and Madras offices was prepared and circulated to the observatories at the end of the year under review.

Inspection of Observatories.

15. A considerable amount of inspection was done during the past year. Eighty-two observatories in all were inspected as compared with an average of 67 during the past five years. The Imperial Reporter inspected 12 stations (including the important first class observatories at Colaba, Madras and Kodaikanal). Four observatories were inspected by Mr. Dallas, Meteorological Reporter for the Punjab, and seven by Mr. Little, Meteorological Reporter to the Government of Bengal. Thirty-two observatories were inspected by Mr. Gaetane, Inspector of observatories, fifteen by the Head Clerk of the Bengal Meteorological office, and twelve by the Head Clerk of the Bombay Meteorological office.

16. The following gives a comparative statement of the condition of the observatories inspected during the year and during each of the previous five years:—

Condition.	Number of observatories inspected in					
	1901-02.	1900-01.	1899-1900.	1898-99.	1897-98.	1896-97.
Very satisfactory	7	10	6	5	6	10
Satisfactory	54	43	27	33	20	39
Fair	12	33	19	19	13	14
Bad	9	13	5	5	5	9
Total	82	99	57	62	44	72

17. A large proportion of the observatories visited during the year were inspected in order to determine whether persistent errors in the observations telegraphed were due to instrumental changes or to careless observation. In the majority of cases the errors were found to be due to changes in the index errors of the instruments, but at the following stations, *viz.*, Bijapur, Faridpur, Motihari, Mymensing, Cherat, Rawalpindi, Ahmednagar and Rajkot, they were found to be due to careless and inaccurate observations.

18. The work of inspection is not yet so fully carried out as I should like to see it. Frequent inspection of observatories, more especially those located at hospitals, dis-

pensaries and post offices is absolutely essential, on account of the occasional changes of observers at short intervals necessitated by acting and other arrangements in the Medical and Postal Departments. Occasionally a half-time observer belonging to one of these departments is transferred at 24 hours' notice and his successor is compelled to take up his work without any training from his predecessor, and it is frequently impossible in such cases to make arrangements to inspect the observatory and train the observer till several months afterwards.

19. The Government of Bengal recently issued instructions for the more frequent inspection of the Bengal observatories by either the Provincial Reporter or his Head Clerk. They laid down the principle that at least half of the observatories in that province should be inspected annually.

Of the 45 observatories in Bengal, exclusive of the Alipore observatory which is under the direct control of the Imperial Reporter but inclusive of the Cooch Behar voluntary observatory, 22 were inspected during the year, *viz.*, 7 by the Provincial Reporter and 15 by his Head Clerk.

Storm Observations.

20. A comparatively small number of special observations of storms were sent in during the year 1901-1902, due in part to the comparative absence of cyclonic storms in India and the Indian seas during the year, and in part to greater strictness in the assignment of rewards, which are now only granted for observations of real value for the investigation of the phenomena and distribution of the various classes of storms which affect weather in India. The great majority of those submitted were observations of the various classes of storms of the hot weather, *i.e.*, thunderstorms, hailstorms and duststorms. About nine hundred sets of storm and other special observations in all were sent in by 85 observers during the year 1901, for which amounts varying from one to sixty rupees were awarded.

Observations of special Meteorological Instruments.

21. The following special observations were carried out during the past year at certain selected stations :—

1st.—Wind observations recorded by Beckley's anemographs at fifteen stations and by Dines's pressure tube anemometers at twelve stations.

2nd.—Solar and terrestrial radiation observations at nine stations.

3rd.—Underground temperature observations at five stations.

4th.—Sunshine observations at six stations.

5th.—Barometric observations recorded by self-registering instruments, chiefly Richard Freres' barographs at twenty-eight stations (an increase of thirteen stations during the present year).

6th.—Thermometric observations recorded by self-registering instruments, chiefly Richard Freres' thermographs at twenty-four stations (an increase of eleven stations during the present year).

22. The only large additions during the past year to this class of work were under the fifth and sixth heads.

Richard Freres' barographs were supplied to Amini Divi, Burdwan, Deesa, Jacobadad, Jodhpur, Mount Abu, Ootacamund, Peshawar, Poona, Quetta, Rangoon, Roorkee and Srinagar, and Richard Freres' thermographs to Burdwan, Deesa, Jacobabad, Jodhpur, Mount Abu, Ootacamund, Peshawar, Poona, Quetta, Rangoon and Roorkee during the year.

Seismograph Observations.

23. Seismological observations were recorded for the Seismological Committee appointed by the British Association by means of Milne's self-registering Seismograph

last year, as in previous years, at Alipore (Calcutta), Colaba (Bombay), and Kodaikanal. All the instruments worked satisfactorily throughout the whole year, and their records were regularly transmitted to the Seismological Committee of the British Association. The working of the seismograph at Alipore, which in the previous year had been adversely affected by the disturbances caused by building operations, was in the year under review entirely satisfactory and its records of the chief disturbances were in accord with those of Colaba and Kodaikanal.

Cirrus cloud observations with Photogrammetres.

24. European Meteorologists have recently devoted much time to observations of the height, direction and rate of movement of the upper clouds. The Government of India in 1896 sanctioned the supply of two pairs of photogrammetres of the most recent and best type in order that India might co-operate in this work, chiefly in the hope that the results would throw light upon the larger and more general movements of the atmosphere. A large number of cloud measurements was made at Allahabad the results of which were compiled and discussed by Mr. Hill, Professor of Natural Science, Muir Central College, Allahabad, and were recently issued as a part of the "Indian Meteorological Memoirs."

25. Similar observations were commenced at Simla during the previous year and continued during the year under review. The results are now ready for publication and will be issued shortly.

Marine Meteorology.

26. This work was carried out during the year under review in the same way as during the past nine years. One clerk of the Calcutta office was engaged during the year in collecting meteorological data from ships entering the Hooghly. He also made a careful comparison by means of secondary standards of the barometers on board the ships from which data were obtained, in order to ascertain the corrections to be applied to the barometric readings extracted from the logs of the vessels. The Bombay Meteorological Office collected data from vessels entering the port of Bombay by the same methods as are employed at Calcutta. The data collected on each day are usually sent off by post to Simla on the following day, any portions that are required for the use of the Calcutta and Bombay offices being copied out without delay. A few logs were received during the year from the Port Officer, Rangoon.

27. The following table gives a statement of the work done under this head during the year, and the corresponding figures of the seven previous years, for comparison :—

		1901-1902.	1900-1901.	1899-1900.	1898-99	1897-98.	1896-97.	1895-96.	1894-95.
Calcutta	Number of logs extracted	1,168	1,322	1,302	1,284	1,325	1,140	1,135	1.076
	Number of barometric comparisons.	4,104	4,104	4,086	4,002	4,218	4,508	4,134	3,892
Bombay	Number of logs extracted	883	991	975	1,005	972	1,017	1,073	1,018
	Number of barometric comparisons.	4,127	5,470	3,900	5,904	5,881	6,197	6,018	3,800

28. Mr. Dallas, Assistant Meteorological Reporter, was in charge of this section of the work of the Department.

29. The issue of Pilot charts, giving month by month the normal meteorological conditions over the Indian seas, was continued. These charts show the mean pressure, the mean direction and force of the wind, the mean surface currents and the ordinary tracks of cyclones in the month under review. Each month's chart was issued about the 20th of the month preceding the period to which it refers. A small charge of four

annas was made for each copy. Thirty copies were sent monthly for distribution to Messrs. Mackinon, Mackenzie and Company, Calcutta, and sixteen copies to Messrs. Turner, Morrison and Company, Calcutta. The total monthly issue amounts to 82 copies.

30. Mr. Dallas completed his investigation into the meteorological history of the seven monsoon seasons referred to in last year's report and the memoir is now in the press.

Snowfall Registration in the Mountain Districts of Northern India.

31. The same methods were employed during the winter of 1901-1902 as in previous years to obtain full and accurate information of the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan Mountain areas. The information for the cold weather of 1901-1902 was on the whole fairly complete.

32. The thanks of the Department are due to the various officers who have collected and forwarded snowfall information during the past winter and more especially to the Deputy Conservators of Forests of the Chamba and Bushahr Divisions for information of special accuracy and value.

Rainfall Registration.

33. No change was made in the system or methods of rainfall registration during the year under review. A full account of the methods employed, which came into full operation during the year 1891-92, will be found in pages 5—8 of the Administration Report of the year 1889-90, and pages 6-7 of the Administration Report of the year 1890-91.

34. The following gives a classified statement of the number of rain-gauge stations reported as inspected during the year 1901-1902, and the total number of rain-gauge stations at the end of the year in the various Political Divisions of the empire:—

Province or Division.	Number of rain-gauges on 31st March 1902.	Number of rain-gauges reported as inspected in 1901-02 (classified).				Percentage of inspections reported to total number of rain-gauges.
		Good.	Fair.	Bad.	Total.	
Baluchistan	54	...	...	...	...	...
Kashmir	41	...	...	...	...	...
Punjab and North-West Frontier Province	215	47	14	4	65	30
United Provinces of Agra and Oudh	277	35	9	1	45	16
Bengal	367	76	16	...	92	25
Assam	116	43	13	1	57	49
Burma	148	48	4	....	52	35
Central Provinces	84	115	3	...	118	140
Berar	44	53	18	1	72	164
Central India	70	...	...	...	...	...
Rajputana	139	22	...	...	22	16
Bombay and Sind	280	...	...	...	...	...
Hyderabad	23	...	...	...	...	...
Mysore	78	...	...	...	...	...
Madras (including Coorg, Travancore, Cochin and Pudukota)	453	247	59	6	312	69
Total	2,389	686	136	13	835	35

35. The registration of rainfall in India has invariably been carried out by the Provincial Authorities and in the larger provinces under the general control of the Boards of Revenue. Previous to 1889 the hours and arrangements for the registration of rainfall differed largely in different provinces. In 1889 a uniform system was introduced by the Government of India, and the Meteorological Reporter to the Government of India was made consulting officer in connection with this work. The local officers superintending the registration of rainfall submit monthly and annual reports to their respective Governments, copies of which are forwarded to the Imperial Meteorological Reporter.

36. The following paragraphs give a brief summary of the reports on rainfall registration submitted to the various Local Governments and administrations by the local officers controlling the rainfall registration:—

37. *Assam.*—The number of stations on the 31st March 1902 was the same as last year, *viz.*, 116 (55 under Government and 61 under private management).

On the whole the work of inspection was well done, only 31 stations remaining unvisited as compared with 48 in the previous year. The best returns come from Darrang (14 out of 15 stations visited), Cachar (13 out of 17), Sylhet and Sibsagar, but in Kamrup, Nowgong, Lakhimpur and the Lushai Hills the proportion of gauges that escaped inspection was unduly large. The Deputy Commissioners of these districts have been requested to pay more attention to this subject.

38. *Bengal.*—The number of rain-gauge stations on the 31st March 1902, was 367, *i.e.*, 5 more than on the corresponding date last year.

Three hundred visits of inspection were made during the year, against 301 during 1900-1901. The total number of rain-gauges inspected was 177, against 194 in the previous year. The reports received from the inspecting officers showed that the rain-gauges were for the most part in good condition and the rainfall registers properly kept.

39. *Berar.*—No change was made during the year in the number of rain-gauge stations.

All the stations remained open throughout the year, no interruptions having been caused by transfer of officers in charge, consequently at each station an unbroken record of rainfall has been preserved.

The number of inspections made during the year under review was in excess of the required amount in the Akola district, entirely due to the attention paid to the work by Major Reilly. In the Amraoti, Basim and Buldana districts the requisite number of inspections were made. In Wun, the Civil Surgeon failed to visit two of his stations during the first half of the year. The deficiency of inspection in Ellichpur is explained to be due to frequent change of officers.

All the Civil Surgeons report that the registration of rainfall has, to the best of their knowledge, been accurately performed, and the results correctly tabulated. The rainfall records are reported to be in a satisfactory condition.

40. *Bombay.*—There were in all 329 rain-gauge stations (an increase of four) in the Bombay Presidency including 60 in Native States.

The amount of inspection performed in the British districts showed a decided improvement over last year. Of the 269 gauges in these districts, 184, or 68 per cent. came under inspection, as compared with 51 per cent. in the previous year. The increase was marked throughout the Presidency, but was specially noteworthy in the Karnátak and Sind, and appears to have been due to the special request made in last year's inspection reports to District Officers to extend the scope of inspection so as to bring all guages under inspection once in the year. In Belgaum, Dhárwár and Kánara all the gauges were inspected.

The amount of inspection in Native States also showed an improvement over the previous year. Forty-four out of the 60 rain-gauges or 73 per cent. were inspected, as

against 60 per cent. of the previous year. Baroda is the only state which forwarded no inspection report.

41. *Burma.*—Two registering stations were opened during the year and two were abandoned. The total number of stations at the end of the year was 149.

Since the inspections noted in last year's report, up till the end of March 1902, only 31 raing-auges have been inspected. The cause of this is that hitherto the report of the local controlling authority has dealt with the rainfall up to the end of March, but with the inspections up to the date of the report, generally June or July. The present year's report, however, deals only with inspections for the year ending the 31st March. And as most of the inspections are made in the months of April, May and June, very few can appear in this report.

Of the 31 rain-gauges inspected, 20 were found in good condition. In two, the registration was found to be defective. In nine cases the gauge was placed in an unsuitable position. At Homalin the Public Works Department are said to have erected a bund behind the gauge, and so interfered with the record of the rainfall.

At Kyaukkyi, in the Toungoo district, the rainfall recorded for the calendar year is only 99·26 inches against a normal rainfall of 130 inches, and enquiries are to be made as to the correctness of the record.

42. *Central Provinces.*—During the year under report two new rain-gauge stations were established in the Chhindwara district, and the eleven rain-gauge stations in the Feudatory States of Chhattisgarh were added to the list of rain-gauge stations maintained in these provinces, for which statistics are published. The additional rainfall data of these tracts give information for an interesting area and throw light upon the distribution of rain by cyclonic storms passing from Orissa into the Central Provinces.

The number of rain-gauges maintained in these Provinces is now 84 as against 72 in the preceding year.

The number of rain-gauge stations inspected during the year under report amounted to 94 as compared with 63 in the preceding year. The increase in the number of inspections is due to the co-operation of the officers of the Public Works Department in the work of inspection of rain-gauge stations on roads under their charge.

The results obtained during the year were reported to be satisfactory.

43. *Madras.*—Rainfall registration was carried out with very little change.

On the 31st March 1901, there were 423 rain-recording stations, excluding 22 meteorological observatories, furnishing rainfall returns for publication in the *Fort St. George Gazette.* To these 8 were added and one was closed during the year, making the total 430 at the end of the year. Of this total, 369 are in the Madras Presidency, and of these 324 were inspected during the year or 88 per cent. of the total number.

All the defects in the Inspection Reports sent in have been or are being rectified. In January 1902 a list of rain-gauges in each district not inspected or reported on since 1st April 1901 was sent to the Collector of that district, with a request that, if possible, these gauges should be inspected before the end of the official year.

44. *North West Frontier Province.*—No separate report received.

45. *Punjab.*—There has been no change in the number of rain registering stations during the year, which, as last year, stands at 214.

The total number of inspections made by Revenue Officers in the Punjab, and reported to this office, was 51 or about 24 per cent. of the whole, as against 88 reported in the previous year.

The decrease in the reported number of inspections is said to be probably due to the omission of some Revenue Officers to submit their inspection reports.

No reports of inspections were received from the Commissioners of the Delhi, Jullunder, Lahore, Peshawar and Derajat Divisions, or from the Deputy Commissioners of Rohtak. Delhi, Umballa, Hoshiarpur, Jullunder, Ludhiana, Jhang, Lahore, Amritsar, Gurdaspur, Sialkot, Shahpur, Jhelum, Dera Ismail Khan, Dera Ghazi Khan and Muzaffargarh Districts.

The reports received from the officers of the Canal Department show that the rain-gauges under their charge have been regularly inspected by Assistant and Executive Engineers from time to time during the year.

The rain-gauges in the Punjab have been kept in good order. One spare measuring glass is kept at each rain-registering station for use in case of emergency.

The observers or the persons entrusted with the duty of measuring the rainfall are said to understand properly how to measure the rainfall and keep the registers in good order.

46. *United Provinces of Agra and Oudh.*—There are 290 rain-reporting stations in these Provinces, including the meteorological observatories and two duplicate stations in the Meerut District, and all use gauges of Symons's pattern.

Regular and *complete* reports of inspections, were received from only 8 districts, the other districts sent only partial reports.

One hundred and fifty-six stations, or nearly 57 per cent. of the whole, were reported as inspected during the year, 23 of them having been inspected more than once. This proportion is less than was reached last year, when 63 per cent. were reported as inspected.

No reports of inspections were received during the year from four districts; from all of them, however, during the previous year more or less complete reports were received.

47. ***Summary.***—The work of rainfall registration is steadily improving and is now satisfactorily carried out over nearly the whole empire.

The work of inspection was best done in Berar and has improved in Assam, Bombay and the Central Provinces. Less inspection was done in Bengal, the Punjab and the United Provinces of Agra and Oudh. The steady improvement in this important branch of meteorological work is very creditable to the various officers in charge of the rainfall registration in the various Provinces of British India.

Normals of the daily and monthly rainfall, based on all the available data up to 31st December 1900, were re-calculated during the year under report and brought into use on 1st January, 1902.

SEASONAL FORECASTS.

48. A forecast of the probable character of the rainfall during the south-west monsoon of 1901 was issued in the same form as in the preceding ten years in the *Gazette of India* of the 8th of June 1901 under the heading of "Memorandum on the snowfall in the mountain districts bordering Northern India, and the abnormal features of the weather in India during the past year, with a forecast of the probable character of the south-west monsoon rains of 1901."

49. The following gives the statement of the forecast as published in this memorandum:—

A. Probable general character of the monsoon currents.

(1) *Judging from the conditions in India and the known conditions in the Indian seas and ocean, it is, on the whole, very probable the monsoon currents of the present year will be, as rain distributing currents, of at least normal strength on the average of the whole season and probable*

that they will be stronger than usual. It should, however, be noted that the heavy rainfall of the past two months in Central or Equatorial Africa points to the possible existence of conditions in that area unfavourable to a strong monsoon in India. So far as can be judged from the available information the probability of this effect is very small.

(2) *The average rainfall of the whole of India will probably be between 2 and 4 inches, or 5 and 10 per cent. in excess.*

(3) *It is probable there may be a slight delay in the establishment of the monsoon currents on the Bombay Coast. The delay will very probably be slight, and it is probable that the rains will set in fully on the Bombay Coast before the middle or end of the second week of June. The monsoon rains will probably begin about the normal date, in the third week of the month, on the Bengal Coast.*

(4) *The Bombay current is more likely to be above its normal strength than the Bay current.*

B. Probable distribution of rainfall in India.—The chief features or local conditions in India which have to be taken into account in estimating the probable distribution of rainfall during the approaching monsoon due to normal or slightly stronger monsoon currents than usual are :—

(1) The distribution of the winter snowfall in the mountain areas to the north and north-west of India.

(2) The abnormal features of the pressure, temperature and humidity conditions of the past five months and more especially the temperature and pressure conditions in May. It is assumed that no large changes of these features will occur during the period of delay of the monsoon in June.

The following inferences respecting the distribution of the south-west monsoon rains of 1901 in India are deduced from the comparison of the antecedent conditions of the present year with those of previous years and are based chiefly on the facts and data stated above :

(1) Conditions are favourable generally in Burma—more especially in Lower Burma. The rainfall of the period will probably be in excess in Lower and Central Burma and about normal or in slight defect in Upper Burma.

(2) Conditions are practically normal in Assam and Bengal and are very slightly more favourable in East and North Bengal and Assam than in West Bengal. These areas will probably receive about normal rain. The rainfall is more likely to be in excess in East and North Bengal than in South-West Bengal. The rainfall in Assam will probably be normal or in slight excess.

(3) Conditions are almost as favourable in Bihar and Chota Nagpur as in the United Provinces of Agra and Oudh. It is probable that the rainfall will be normal in Chota Nagpur and normal or in slight excess in Bihar.

(4) Conditions are favourable in the United Provinces of Agra and Oudh—more especially in the eastern districts where there is a local deficiency of pressure of some importance. It is very probable that the rainfall will be in slight to moderate excess, except in the south-western and western districts, where it may be normal.

(5) Conditions are slightly unfavourable in the Punjab, due chiefly to the excess of pressure in the northern districts—a residual effect of the late heavy snowfall in Kashmir and Chitral. On the supposition of a monsoon of normal strength, it is probable that the monsoon rainfall of the present

year will probably be about normal in the eastern districts and below the normal to a moderate extent in the western and northern districts. The character of the rainfall in this area, however, depends chiefly on the general strength of the monsoon and not on the local conditions, and these conclusions should be suitably modified if the monsoon turns out to be stronger than is assumed in drawing up the forecast.

(6) Conditions are, on the whole, favourable in Rajputana—more especially in the eastern and central districts. The monsoon rainfall will hence very probably be normal or in slight excess. The rainfall in Rajputana, as in the Punjab, depends chiefly on the general strength of the monsoon, and hence if the Bombay monsoon current be strong, the rainfall may be favourable and in excess over the whole area.

(7) Conditions are almost as favourable in Central India as in the United Provinces of Agra and Oudh, and it is probable that area will receive about normal rainfall. The rainfall is more likely to be in excess in the eastern than the western states.

(8) Conditions are, on the whole favourable in the Central Provinces and Hyderabad. It is hence probable that these areas will receive at least normal rainfall. The conditions are slightly more favourable in the eastern than the western districts of the Central Provinces, and it is hence probable that the eastern districts may receive rainfall in slight to moderate excess of the normal. They are very slightly less favourable in Hyderabad than the Central Provinces, and the rainfall in that area will probably be normal or in slight excess.

(9) Conditions are practically normal in Berar and Khandesh, and the rainfall in these areas will probably be about normal. They are more favourable in the West Deccan and that area will very probably receive its normal fall.

(10) The conditions in the west coast districts are such as are, in years of normal monsoon conditions, usually associated with normal rainfall. It is hence probable that the rainfall of the present year's south-west monsoon will be in moderate to considerable excess in those districts, if, as is not probable, the rains are not greatly delayed. It is probable it will be normal in Malabar.

(11) The variations of the rainfall in the North Madras Coast districts are in at least five years out of six similar to those of Orissa and the Central Provinces. Conditions appear to be, on the whole, favourable, and it is probable those districts will receive about normal rain.

(12) A comparison of the conditions in the Madras Deccan, Mysore and the Carnatic with those of similar years indicates that the rainfall during the period—June to September—will probably be in slight excess in Mysore and the Deccan—more especially in Mysore and normal or in slight defect in the Carnatic. It is difficult to forecast for this part of India, as rain in the southern half of the Peninsula during the monsoon proper occurs chiefly during the intervals of breaks in the rains in Northern India, and is hence essentially of irregular occurrence.

It should be carefully noted that the preceding probabilities are obtained on the assumption that the currents will be about normal or slightly stronger than usual. They will require to be suitably modified if the monsoon currents should be much weaker than is anticipated from the data. It should also be noted that the chances for an inference stated to be very probable are at least 5 to 1 and for an inference stated to be probable at least 5 to 2.

50. The following table gives for 14 political divisions rainfall data of the south-west monsoon of 1901 for comparison with the forecast:—

Province or Division.	Rainfall of Season, June to October.			
	Average actual, 1901.	Average normal.	Variation of actual from normal.	Percentage variation from normal.
	Inches.	Inches.	Inches.	
Burma	99·05	...	...	...
Assam	74·88	77·21	— 2·33	— 3
Bengal	58·45	60·71	— 2·26	— 4
Chota Nagpur	41·13	47·40	— 6·27	—13
Bihar	30·34	43·59	—13·25	—30
United Provinces of Agra and Oudh . .	28·39	34·70	— 6·31	—18
Punjab	10·88	15·14	— 4·26	—28
Baluchistan	1·34	2·43	— 1·09	—45
Central Provinces	43·44	45·83	— 2·39	— 5
Central India	31·57	40·08	— 8·51	—21
Rajputana	10·90	18·70	— 7·80	—42
Berar	32·41	37·48	— 5·07	—14
Bombay	32·11	41·44	— 9·33	—23
Madras	30·69	34·06	— 3·37	—10

51. The forecast was less satisfactory than usual, the result chiefly of an unduly sanguine estimate of the strength of the monsoon currents. The general distribution of the rainfall, as indicated by the forecast, was on the whole in moderate accordance with facts as far as related to Burma, Bengal, the Punjab, the Central Provinces, Bombay (except North Bombay) and South Madras.

52. The following is the forecast of the winter rains of 1901-02 (*i.e.*, from December 1901 to February 1902), as issued in the second week of December 1901 to the Government of India:—

(1) The winter precipitation in Persia will very probably be below the normal to a moderate extent and in Baluchistan to a slight extent.

(2) The snowfall in the Punjab Himalayas and the Afghan mountains will very probably not be above the normal and will probably be in moderate to considerable defect over the greater part of the area. The vertical positive anomalies at Leh (if the observations are correct) are abnormally large and very unfavourable for heavy snow in Thibet and the higher and interior ranges of the Western Himalayas.

(3) The small positive vertical anomalies at Darjeeling probably indicate that the snowfall over the Eastern Himalayas during the next three months will be about normal.

(4) The winter rains due to cold-weather storms originating in the Persian area in Upper India, *i.e.*, the Punjab, Sind and Rajputana (from December to February) will very probably not be above the normal and probably be in slight to moderate defect.

(5) It is very probable that the winter precipitation in the Gangetic Plain due to the same causes will be in moderate defect.

(6) It is probable that, as indicated by the temperature and pressure conditions in October and November, light to moderate rain due to local disturbances may be received from December to March in Central India and the Central Provinces, and in perhaps the adjacent districts of Chota Nagpur, Rajputana and the United Provinces of Agra and Oudh, and hence that the precipitation of the period due to both causes may be above the normal.

(7) The probability of an early commencement of the winter rains in the plains of Upper or Central India is slight and it is very probable they will not commence before the fourth week of December.

53. The following statement gives comparative rainfall data of the larger provinces of Northern and Central India for the period December 1901 to February 1902:—

Province or Division.	Rainfall of period, December to February.			
	Average actual, 1901-02.	Average normal.	Variation of actual from normal.	Percentage variation from normal.
	Inches.	Inches.	Inches.	
Assam	0·74	2·66	—1·92	—72
Bengal	0·03	1·44	—1·41	—98
Chota Nagpur	0·59	1·54	—0·95	—62
Bihar	0·15	1·39	—1·24	—89
United Provinces of Agra and Oudh	0·42	1·64	—1·22	—74
Punjab	0·12	2·33	—2·21	—95
Baluchistan	0·04	3·91	—3·87	—99
Central Provinces	0·27	1·17	—0·90	—77
Central India	1·26	1·26	0	0
Rajputana	0·13	0·68	—0·55	—81
Berar	0·13	1·06	—0·93	—88
Bombay	0·15	0·46	—0·31	—67
Madras	3·85	2·55	+1·30	+51
Burma	0·31	...	...	...

54. The forecast of the cold weather rainfall accurately foreshadowed the general deficiency of rainfall, but the very large deficiencies in the Punjab, Rajputana, Berar, Bihar, and Bengal were not fully anticipated. It may be noted that pressure conditions were very abnormal in Central Asia and South and East Europe during the months of January and February 1902, and there are reasons to believe that the complete absence of the usual cold weather disturbances in Northern India during this period was directly related to these conditions. Our only source of meteorological information for these regions are the weather charts issued by the Russian Meteorological Office, but as the December charts do not arrive in Simla before the first week of February, it is not possible to utilize their indications in drawing up winter forecasts.

Storm Warnings.

55. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed by two officers. Ports on the Bay of Bengal are warned from the

Calcutta Office by the Meteorological Reporter to the Government of Bengal, and ports on the Arabian Sea coast from the Simla Office by the Meteorological Reporter or Assistant Meteorological Reporter to the Government of India.

The present system of storm signals was brought into operation on the 1st April 1898.

The complete system at present in operation includes:—

1st.—An extended system of storm signals for use at the larger and more important ports.

2nd.—A brief system of storm signals for use at the smaller ports, chiefly for the information of native or country vessels.

56. ***Bay of Bengal Storm Signal Service.***—The following gives a list of the ports which were warned during the year 1901-02 by the Meteorological Reporter to the Government of Bengal:—

(*a*) *Burma Ports*—	(*b*) *Bengal Ports*—	(*c*) *Madras Ports*—
Mergui.	Calcutta and River Hooghly.	Gopalpur.
Tavoy.	Narayanganj.	Bimlipatam.
Moulmein.	Chittagong.	Vizagapatam.
Rangoon.	Orissa Ports, including Puri,	Cocanada.
Bassein.	False Point, Chandbali and	Masulipatam.
Akyab.	Balasore.	Madras.
		Negapatam.
		Pamban.
		Tuticorin.

The following gives the arrangement of the ports according to the method of warnings adopted:—

BAY OF BENGAL PORTS.

I.—By extended system.			*II.—By brief system.*
Tavoy.	Calcutta and River Hooghly.	Cocanada.	Narayanganj.
Moulmein.	False Point.	Masulipatam.	Balasore.
Rangoon.	Puri.	Madras.	Chandbali.
Bassein.	Gopalpur.	Negapatam.	
Akyab.	Bimlipatam.	Pamban.	
Chittagong.	Vizagapatam.	Tuticorin.	

Telegraphic information is also sent to Chittagong, Narayanganj and the Orissa ports whenever storm signals are hoisted at Saugor Island. This extension was suggested by the Government of Bengal in May 1898.

It may be noted that in the case of the Bengal ports, the signals are hoisted by the direct orders of the Meteorological Reporter to the Government of Bengal. In the cases of the Burma and Coromandel coast ports, the storm signals are hoisted by the orders of the port officers, acting on information respecting the path and intensity of the storms received at short intervals during their progress from the Meteorological Reporter to the Government of Bengal.

The Indian seas were remarkably free from severe storms during the year under report. In all seven cyclonic storms or disturbances, of which four were of slight intensity, and the remaining three of moderate intensity, formed in the Bay during the year, and affected the ports warned by the Bengal Reporter, and of all of them due warnings were given to the ports concerned.

There are also certain special arrangements at Calcutta for supplying the latest weather information by means of flag signal hoist messages to certain ports of the Bay for the information of outward-bound shipping when passing Saugor Island, and for obtaining early information of the weather at the head of the Bay from vessels entering the Hooghly. These arrangements worked satisfactorily throughout the year, and occasionally gave information of much value to the mail and coasting steamers of the British India, and other, shipping companies.

57. ***Bombay Storm Signal Service.***—The work of warning the Bombay ports was carried out during the past year by the Simla Meteorological Office under the arrangements introduced in September 1889, and fully stated in pages 17 and 18 of the Administration Report of 1889-90. The Simla Office also warned the Madras ports on the Malabar coast in the same manner as the Bengal Reporter warned the Madras ports on the coast of the Bay of Bengal. Warnings of storms in the Arabian Sea were also sent to the Port Officer, Aden, for the information of steamers leaving that port for Colombo, Bombay and Kurrachee.

The following is a list of the Bombay and Malabar ports warned under this system during the year 1901-02 by the Simla Meteorological Office :—

(*a*) *Bombay Ports.*			(*b*) *Malabar Ports.*
Kurrachee.	Daman.	Vengurla.	Mangalore.
Cutch-Mandvi.	Bombay.	Goa.	Tellicherry.
Dwarka.	Alibag.	Mormugao.	Calicut.
Porbandar.	Murud Janjira.	Karwar.	Cochin.
Veraval.	Ratnagiri.	Kumta.	
Jafrabad.	Malwan.	Honavar.	(*c*) Colombo.
Bhavnagar.			

The following gives the arrangement of the ports according to the method or system of storm signals adopted :—

ARABIAN SEA PORTS.

I.—By extended system.	*II.—By brief system.*	
Kurrachee.	Cutch-Mandvi.	Ratnagiri.
Bombay.	Dwarka.	Malwan.
Mormugao.	Porbandar.	Vengurla.
Mangalore.	Veraval.	Goa.
Tellicherry.	Jafrabad.	Karwar.
Calicut.	Bhavnagar.	Kumta.
Cochin.	Daman.	Honavar.
	Alibag.	
	Murud-Janjira.	

Weather was stormy in the Arabian Sea during the last week of April and the first four days of May and feebly disturbed in the first week of June and the third week of October. Ample and early information was on these occasions given to the ports affected.

58. The storm warning work was carried out satisfactorily by the warning officers at Simla and Calcutta. Ample and early definite warning was, so far as I can judge, given in the case of all the more important storms which visited the coasts of India in 1901-02.

FLOOD WARNINGS AND WEATHER FORECASTS TO DISTRICT OFFICERS, IRRIGATION AND OTHER OFFICERS OF THE PUBLIC WORKS DEPARTMENT AND TO EXPEDITIONS IN THE FIELD.

59. This work is chiefly carried out by the Simla Meteorological Office. The arrangements for it have been sanctioned at various times, and differ considerably in character, depending upon the nature and extent of the flood or weather warnings required by the officers concerned. The common feature of the work is that individual officers receive special warning telegrams when necessary, in order to enable them to take precautionary measures for the safety of the works or of the district under their charge.

60. Warnings of heavy rain likely to give rise to serious floods in the Nerbudda, Tapti, Sabarmati or Mahi rivers are sent to twelve officers in the districts of Gujarat, Kathiawar, Bombay and Khandesh. Telegrams are sent by the Simla Office warning these officers of the existence of storms likely to give heavy rain and severe floods, and the meteorological observers at Hoshangabad, Jubbulpore, Khandwa, Pachmarhi, Amraoti, Akola and

Chikalda telegraph directly to the same officers the actual occurrence of heavy rain at their respective stations.

61. The arrangements by which weather and flood warning telegrams are sent to certain Public Works, Railway and Irrigation officers were fully stated in pages 30—31 of the Administration Report for 1889-90. In some cases, the officers concerned require telegrams warning them of advancing storms likely to give heavy rain; in other cases, they require telegrams giving information of actual heavy rainfall in the hill districts likely to give rise to severe floods which might injure the railways or canal works in the submontane districts under their charge; and in others, they require warnings or forecasts of the weather for as long a period beforehand as possible, so as to enable them to modify their arrangements for carrying on the works under their charge, so far as may be necessitated by sudden or large changes of weather.

62. The number of district officers and officers in the Irrigation, Railway and Public Works Departments requiring warnings amounted at the end of the year to 67.

63. The list of officers warned does not include captains of mail steamers and other vessels who occasionally telegraph from Kurachee, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

Seven hundred and forty-five special warning messages were sent last year, as compared with 509 in the previous year, thus showing an increase of about 50 per cent. in this section of the work of the Department.

64. Warnings of floods or of heavy rainfall were issued by the Bengal Reporter to sixteen officers of the Public Works and other Departments in the province of Bengal.

65. Instructions were issued three years ago by the Government of India that every officer to whom storm or flood warnings are issued, should in the month of January of each year or, in the case of military expeditions, at the close of the campaign, forward to the Meteorological Reporter to the Government of India a brief return of the warnings received during the past year and should also report :—

(1) Whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

(2) Whether the warnings were timely and satisfactory in every respect, and, if not, in what points they were defective.

(3) Whether any changes might be made in the system which would make the warnings more useful and effective.

66. Opinions were received from nearly all of the officers who received storm, flood or other warnings during the year. The great majority indicated that the warnings were timely and satisfactory, and that they could not suggest any change for their improvement. They also indicated that the warning telegrams were forwarded rapidly by the Telegraph Department.

67. Every effort is being made to improve the flood telegrams, but in some districts in India, more especially the Punjab, it is very difficult to forecast with approximate accuracy the occurrence of heavy rain more than 12 to 24 hours before its actual occurrence.

PUBLICATIONS.

A.—WEATHER REPORTS.

68. ***India Weather Reports.***—The following weather reports, giving information of the current weather to the Government and the Public, were published during the year by the India Meteorological Office :—

(1) India Daily Weather Report and Chart.

(2) India Weekly Weather Report, giving an account of the weather and of the

rainfall of the week ending on the previous Saturday, published in the *Gazette of India* every Saturday.

(3) India Monthly Weather Review, giving a general summary and a full review of all the important features of the weather and complete meteorological data of the month.

India Daily Weather Report and Chart.—New small charts shewing the pressure and temperature variations from normal were added to the chart from the 1st of August 1900.

The number of stations for which data were given in the daily report of the 31st of March 1901 was 158, and in that of the 31st March 1902, 161.

The daily weather report was issued to an average number of 444 recipients during the year, or 34 more than in the previous year. The chief increase was in the number supplied to Government Offices which rose from 349 to 372.

India Weekly Weather Report.—The Weekly Weather Report was published in the *Gazette of India* in the same form as in the previous eight years, during the period, 1st April to 19th October. From that date the weekly rainfall reports from district officers were, by the orders of the Government of India, discontinued and the weekly rainfall reports were thenceforward prepared from the data supplied by the meteorological observatories alone. At the same time the end of the rainfall week was changed from 8 A.M. on Saturdays to 8 A.M. on Thursdays so as to enable the Meteorological Department to publish in each Saturday's *Gazette of India* the rainfall data for the week ending two days previously. The rainfall information now published in each *Gazette* is thus more up to date, if somewhat less complete, than it was under the previous arrangement.

India Monthly Weather Review.—The following gives the dates of issue of the parts of the Monthly Weather Review for the past year :—

		Date of issue.			Date of issue.
April	1901	16th August 1901	October	1901	19th February 1902
May	„	14th September „	November	„	21st March „
June	„	10th October „	December	„	14th April „
July	„	16th November „	January	1902	26th May „
August	„	17th December „	February	„	19th July „
September	„	21st January 1902	March	„	22nd August „

Annual Summary.—The annual summary for 1900, supplementing the Monthly Weather Reviews for that year, was issued on the 29th November 1901. It contains mean data for the year 1900, and a discussion of the more important meteorological features of the year and of their relations to each other. A summary of the meteorology of the year 1900 was prepared for the Sanitary Commissioner with the Government of India, and was given as Chapter I of the Annual Report of that officer for the year 1900-1901.

Special Charts.—The Simla Office prepared throughout the year weekly charts (drawn by hand) showing the week's actual and normal rainfall and the actuals and normals of the seasonal rainfall up to date, for the use of His Excellency the Viceroy, His Majesty's Under-Secretary of State for India, London, and of the Secretary to the Government of India in the Revenue and Agricultural Department. Similar charts were also forwarded from 1st April to 19th October 1901 to the Imperial Bacteriologist, Muktesar, the Secretary to the Government of India, Finance and Commerce Department, and the Deputy Secretary, Military Department.

The Calcutta Office prepared four series of average seasonal rainfall charts and annual rainfall charts of the whole of India, as in previous years, for the information of the Government of India and the Secretary of State.

69. ***Provincial Weather Reports.***—The following provincial reports were issued by the provincial Reporters during the year :—

(1) By the Bengal Reporter—

(*a*) Bay of Bengal Daily Weather Report and Chart issued during April, November and December 1901, and January to March 1902.

(*b*) Bengal Daily Weather Report and Chart issued during the period May to October 1901.

(*c*) Monthly Rainfall Table for Bengal and Meteorological Table for Bengal and Assam with a summary of the chief features of the weather of the month published in the Provincial *Gazette.*

(*d*) Report on the Meteorology of Bengal for the monsoon season of 1901, illustrated with rainfall maps published in the Provincial *Gazette.*

(*e*) Short annual report on the meteorology of Bengal for the year 1901, illustrated with rainfall maps published in the Provincial *Gazette.*

(2) By the Bombay Reporter—

(*a*) Bombay Daily Weather Report and Chart.

(*b*) Brief sketch of the meteorology of the Bombay Presidency during the year 1900-01.

(3) By the Madras Reporter—

(*a*) Madras Daily Weather Report and Chart.

(*b*) Monthly Rainfall Table for Madras, Coorg, Pudukota, Cochin and Travancore published in the Provincial *Gazette.*

(4) By the Meteorological Reporter to the Government of the United Provinces of Agra and Oudh—

(*a*) Monthly Weather Summary of the province published in the Provincial *Gazette.*

(*b*) Brief sketch of the meteorology of the province for the year 1900-01.

(*c*) Monthly Rainfall Table for the United Provinces of Agra and Oudh published in the Provincial *Gazette.*

(5) By the Meteorological Reporter for the Punjab—

(*a*) Monthly summary of the weather of the Punjab published in the Provincial *Gazette.*

(*b*) Annual meteorological summary of the Punjab for the year 1900-01.

B.—Indian Meteorological Memoirs.

70. The following were issued during the year :—

(1) Cloud observations recorded at Allahabad during the years 1898-1900, by E. G. Hill, Esquire, Professor of Natural Science, Muir Central College, Allahabad (Indian Meteorological Memoirs, Vol. XI, Part III).

(2) Discussion of the hourly observations recorded at twenty-nine stations in India, given in volumes V, IX and X of the Indian Meteorological Memoirs, by the Meteorological Reporter to the Government of India and Director-General of Indian Observatories (Indian Meteorological Memoirs, Vol. XII, Part II).

(3) Daily normals of Maximum temperature, Minimum temperature, 8 A.M. Air pressure reduced to 32°, and Rainfall, with Five-day means of normal 8 A.M. Cloud amount, Relative humidity and Aqueous vapour pressure at 8 A.M., by the Meteorological Reporter to the Government of India and Director

General of Indian Observatories (Indian Meteorological Memoirs, Vol. XIII).

71. The following are now in the press and will be issued during 1902-1903 :—

(1) Discussion of the hourly observations recorded at twenty-nine stations in India, given in volumes V, IX and X of the Indian Meteorological Memoirs, (Final Chapter and Conclusion) by the Meteorological Reporter to the Government of India and Director General of Indian Observatories.

(2) Meteorological history of the seven monsoon seasons, 1893-1899, in relation to the Indian Rainfall, by the 1st Scientific Assistant to the Meteorological Reporter to the Government of India.

C.—Other publications.

72. The following were issued during the year :—

(1) A new edition of the Hand-Book of Cyclonic Storms in the Bay of Bengal, by the Meteorological Reporter to the Government of India and Director General of Indian Observatories.

(2) Saugor Island Weather Signal Code adapted to Elson's Code Equivalents prepared by Mr. S. R. Elson, late of the Bengal Pilot Service.

Meteorological Offices.

73. The India Meteorological Office and the Alipore Central Observatory are now located in buildings in the same compound at Alipore, an arrangement which has considerably improved the character of the work in both offices. The Simla Meteorological Office which forms virtually a part of the Central Office, issues the India Daily Weather Report and the India Weekly Weather Report and carries out an increasing amount of the ordinary current and special work of the Head office, such as preparing data for the monthly weather reviews, for the annual summary and for special memoirs.

In addition to the Imperial Meteorological offices at Alipore (Calcutta) and Simla, there are Provincial Meteorological offices at Allahabad, Bombay, Calcutta and Madras.

Library.

74. Five hundred and seventy-three books and pamphlets were added to the Library during the year, which were either purchased or presented by scientific bodies. The Library is in good order.

Six libraries and foreign observatories and societies were added during the year 1901-1902 to the list to which the publications of the India Meteorological Department are supplied bringing the number on the list up to 338.

Concluding Remarks.

75. The Meteorological Department received valuable assistance in its work from the Survey, Telegraph and Postal Departments during the year.

76. The Telegraph Department has continued to assist the Department by the rapid transmission of storm and flood-warning telegrams during the year. There are in all twenty-six observatories established at Departmental Telegraph Offices, the observations being taken in either by the telegraph master or by a signaller, and all worked satisfactorily during the year except Dibrugarh and Rawalpindi.

77. By permission of the Postal Department, meteorological observatories have been established at sixteen combined Postal and Telegraph Offices. Observations at the great majority of these stations are taken by one of the telegraph signallers, but in one or two

cases they are recorded by the post masters. All these observatories, with the exception of Cherat, Chaman and Sirsa, worked satisfactorily during the year.

78. Daily weather telegrams from Aden were sent free of charge to Bombay by the Eastern Telegraph Company during the year, and were thence forwarded as ordinary service weather telegrams to Simla, where they usually arrived during the year about an hour-and-a-half after despatch from Aden. The Department is greatly indebted to the Eastern Telegraph Company for this valuable concession, and to the local officers of the Company for the rapid transmission of the weather messages.

79. The observatories at Teheran and Ispahan at the telegraph offices of these stations on the Indo-European telegraph line furnished valuable observations during the year. Daily 9 hour observations registers were also received during the year from Singapur and Penang through the courtesy of the Principal Civil Medical Officer, Singapur, and the Colonial Surgeon, Penang. Daily weather telegrams were transmitted, free of cost, to the department, from Bushire and Jask throughout the whole year, and from Ispahan and Teheran throughout the cold weather from the 16th of November 1901 to the 7th of May 1902. These telegrams were of great service to the department in forecasting the approach of cold weather storms from Persia to Northern India, and the department is greatly indebted to the Directors of the Persian Gulf Section and the Persian Section for this most useful and valuable concession.

80. Weekly telegrams were received during the south-west monsoon period from the departmental observatories at Zanzibar and the Seychelles and also from the Royal Alfred Observatory, Mauritius. These telegrams gave valuable information during the south-west monsoon period and the department is indebted to the officers for their punctual transmission of the telegrams and more especially to the Director of the Royal Alfred Observatory for his courtesy in placing the Meteorological data of that station at the disposal of the India Meteorological Department.

81. The Department was greatly indebted for very valuable meteorological information received during the monsoon from Mr. Hutchins, Conservator of Forests, Cape Colony and from Cairo.

82. The co-operation of the Provincial Reporters, more especially Messrs. Dallas and Jones, and of Mr. Küchler, Assistant Meteorological Reporter, in charge of the Central Observatory at Alipore, has contributed largely to the progress of the Department during the past year.

83. Mr. W. A. Bion, First Assistant, and Lala Hem Raj, Second Assistant, in the India Meteorological Office, Simla, have both done excellent work throughout the year.

84. I desire to place on record the names of the following subordinate officers in the Simla and Calcutta Meteorological offices who have done good service during the past year:—

(1) Babu Fanindra Mohan Basu, Head Clerk of the Calcutta Central Meteorological office.

(2) Babu Allah Bakhsh, Head Clerk of the Simla Meteorological office.

(3) Babu Nirduksha Kumar Ghosh, Chief Computer of the Calcutta Central Meteorological office.

(4) Babu Nirbhai Singh, Computer of the Simla Meteorological office.

JOHN MURRAY,

Officiating Meteorological Reporter to the Government of India and Director General of Indian Observatories.

METEOROLOGICAL OFFICE, INDIA;
Alipore (Calcutta), the 27th June 190.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

REPORT

ON

THE ADMINISTRATION

OF

THE METEOROLOGICAL DEPARTMENT

OF

THE GOVERNMENT OF INDIA

IN

1902-1903.

OBSERVATORIES.

1. The observatories maintained by the Government of India are classified as follows:—

First class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, rainfall and wind direction and velocity.

Second class.—Observatories at which observations are taken daily at 8 hours and (with a few exceptions) transmitted by weather telegram to Simla, Calcutta, Bombay or Madras for inclusion in the India or Provincial Daily Weather Reports, and at which additional observations are recorded at 10 hours and 16 hours.

Third class.—Observatories—

(*a*) at stations where there are telegraph offices, and at which observations are taken daily at 8 hours only, and transmitted by weather telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports;

(*b*) at stations where there are no telegraph offices, and which record observations at 10 hours and 16 hours only, in some cases for inclusion in the Monthly Weather Reviews, and in others to furnish a series of 11 years' observations for the determination of monthly and daily means for these stations, which shall be comparable with the means already obtained for second class observatories. At a few such stations, chiefly Extra Indian, observations are recorded at 8 hours only.

Fourth class.—Observatories at which observations of temperature, wind direction and rainfall only are recorded.

2. At the commencement of the year 236 observatories contributed registers of meteorological data, of which 50 were non-departmental, and 186 maintained by the Government of India. At the end of the year the total number of observatories was 240 of which 50 were non-departmental and 190 maintained by the Government of India.

Of the 190 departmental observatories, 7 were first class, 38 were second class and 145 third class.

3. The following gives the changes in non-departmental observatories during the year :—

(1) A third class observatory was opened at Bharatpur on the 7th May 1902.
(2) The fourth class observatory at Lungleh was closed on the 1st March 1903.

4. The following gives the changes in departmental observatories during the year under review :—

(1) The second class observatory at Kailang was reduced to the third class on the 1st January 1903.
(2) The observatory at Wellington was reduced from second to third class on the 17th May 1902.
(3) Third class observatories were opened at Gauhati, Cherra Poonjee, Shillong, Dodabetta and Monywa on the 15th May 1902, the 1st June 1902, the 12th June 1902, the 21st June 1902 and the 2nd January 1903, respectively.
(4) The third class observatory at Kindat was closed on the 15th December 1902.

5. The observatory at Dodabetta is furnished with continuous self-registering barograph, thermograph and Beckley's anemograph in addition to the usual instruments for eye observations. The observatory was inspected by Mr. Jones and myself in January last, and arrangements made for the work of observation, by which the observer visits it daily from 10 A.M. to 4 P.M. and records a short series of eye observations for comparison with the traces of the barograph and thermograph.

6. The two observatories on the Chor Peak, sanctioned in 1899, have been erected and the difficulties from snow at the higher station prove to be less than were anticipated Observers have been appointed and instruments of the usual type, with self-recording apparatus working for a day for the lower station have been provided. Messrs. Casella and Co. were asked upwards of a year ago to give an estimate for self-recording instruments capable of continuous registration for several months required for the upper station, but none has been as yet received.

7. The anemograph which was formerly upon the roof of the Town Hall at Simla had to be removed when certain changes in that building were commenced in October 1902. As the changes were such as to render it impossible to place the anemograph on that building again it was decided to utilize it elsewhere. It was taken to Cherat and placed on a tower of the Water Works erected by the Military Works Department and near the reservoir at the highest point in the station. As the winds at this place are very remarkable, more especially in the cold weather, it is hoped that in the course of a few years very interesting results may be obtained.

8. Buildings for the reception of the instruments for the Pendra Road observatory have been erected and arrangements are being made to start the work of observation which, it is hoped, will be effected by the end of June 1903.

First Class Observatories.

9. The Directors of the Government observatories of Kodaikanal, Madras and Bombay, publish separate annual reports which are forwarded through the Department for the information of Government. It has hence been ruled that under present arrangements it is unnecessary to include information relating to the working of these observatories in the Adminstration Report of the Meteorological Department.

10. *The Alipore Observatory.*—This observatory is under the charge of the Second Assistant Meteorological Reporter to the Government of India. It is furnished with a

complete set of autographic instruments, including a sunshine recorder, a Kew barograph and thermograph, a Beckley's anemograph, a Dines's pressure tube anemometer, a Beckley's rain gauge and also a Milne's horizontal pendulum seismograph.

11. The self-registering instruments worked satisfactorily during the past year. The measurements from the traces of the barograph and thermograph have been compared with the eye-readings of the standard barometer, and the dry and wet bulbs in the same manner as in the previous thirteen years. The following gives the mean differences for the year 1902 and also for the past thirteen years :—

	Period 1889-98.	Period 1899-1901.*	Period 1899-1902.*	1901.	1902.
Mean difference between the standard barometer and barograph during the period or year (*i.e.*, standard barometer *minus* barograph) . .	" +·022	" +·024	" +·024	" +·025	" +·025
Mean difference between the dry bulb in the thermometer shed and the dry bulb trace of the thermograph (*i.e.*, thermograph *minus* shed dry bulb thermometer)	° +0·61	° —0·09	° —0·11	° —0·13	° —0·18
Mean difference between the wet bulb in the thermometer shed and the wet bulb trace of the thermograph (*i.e.*, thermograph *minus* wet bulb thermometer)	° +0·74	° +0·73	° +0·80	° +1·08	° +1·00

* Exposure was slightly changed during this period by removing certain trees which impeded the free circulation of the air round the thermometers.

12. All instruments issued by the Meteorological Department are carefully tested at this observatory and their corrections ascertained before they are sent out for use. A smaller amount of work in testing instruments than usual was done during the year. Three hundred and thirty-nine instruments were tested and verified during the year (as compared with 505 tested last year). Forty-seven instruments were condemned as unfit for issue, or were sent for repair to the Mathematical Instrument Department.

13. The observatory gives mean Calcutta time to the port and shipping. Three timeballs were dropped daily at 1 P.M. local mean time during the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore Docks.

This work was, on the whole, carried out satisfactorily during the year. There were fourteen failures as compared with the average number 10·5 of the past fourteen years :—

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1902-1903	14	14
1901-1902	13	13
1900-1901	15	15
1899-1900	13	13
1898-1899	6	6
Mean of ten years 1888-98	10	10

14. *The Allahabad Observatory.*—This observatory is under the charge of the Meteorological Reporter to the Government of the United Provinces of Agra and Oudh. Observations are taken of a considerable number of instruments, in addition to those of the

ordinary meteorological instruments supplied to all observatories. The following is a statement of these instruments and of the records obtained from them :—

The Beckley's anemograph requires overhauling but gave satisfactory wind records during the year. The sunshine recorder worked well throughout the year, and the Draper's thermograph fairly well. The records are all tabulated to date.

The Dines's pressure tube anemometer was not in working order during the year.

Regular observations of the nature and movements of clouds were made throughout the year with the aid of a Duboscq's nephescope.

A continuous record of the barometric pressure throughout the year was obtained by a Richard Freres' open scale barograph. The records (which have all been tabulated) are satisfactory.

A Richard Frere's thermograph was in use throughout the year. It gave excellent results as a dry bulb instrument. Its wet bulb record was not satisfactory in the hot weather.

A battery of four solar radiation thermometers to measure the intensity of the sun's heat, and a grass thermometer to measure terrestrial radiation were in use during the year.

Ground temperatures at the surface, and at depths of one and three feet were recorded at 6h., 14h. and 22h. The temperature at the depth of 9 feet was observed at 14h.

15. *The Lahore Observatory.*—No change was made in the work of this observatory. Eye observations of all instruments are recorded seven times per diem and automatic records of pressure, temperature, sunshine, wind and rain are obtained from self-registering instruments. A valuable series of underground temperature observations are made at the observatory, and arrangements have been made to increase the depth at which these observations are recorded, so that in future these records will refer to depths of 1 foot, 3 feet, 6 feet, 12½ feet and 25 feet.

Character of the work of observation at Second and Third Class Observatories.

16. In general the character of the work of the observatories showed an improvement during the year under review.

17. A good test of the carefulness and accuracy of the observers is the correctness of the weather telegrams they forward to Simla. The work done at 149 of the 168 meteorological observatories reporting daily by telegraph to Simla (88 per cent. of the whole) was entirely satisfactory and the observations trustworthy and accurate throughout the year. At the following six departmental observatories the work was very unsatisfactory, *viz.*, Mandalay, Bassein, Akyab, Bhamo, Bahraich and Toungoo. The number of erroneous observations detected during the year at Mandalay was 89, at Bassein 83 and Akyab 58. Five out of these observatories are in Burma. The work of observation has, for many years past, been more carelessly done in Burma than in any other province, and it is to be regretted that the work of the past year shows deterioration instead of improvement. The Burma observatories are hence, on the whole, the least satisfactory in India at the present time. The usual list showing the number of observations rejected, and also the number of telegrams incorrectly prepared, for all departmental observatories which send weather telegrams to the Simla, Calcutta, Bombay and Madras offices, was prepared and circulated to the observatories at the end of the year under review.

Inspection of Observatories.

18. A considerable amount of inspection was done during the past year. Eighty-six observatories in all were inspected as compared with an average of 69 during the past six years. The Imperial Reporter inspected 14 stations (including the important first class observatories at Colaba, Madras and Kodaikanal). Six observatories were inspected by Mr. Little, Meteorological Reporter to the Government of Bengal. Thirty-six observatories were inspected by Mr. Gaetane, Inspector of Observatories, sixteen by the Head Clerk of the Bengal Meteorological office, four by the Head Clerk of the Bombay Meteorological office, four by the Chief Observer of the Allahabad Observatory, four by the Head Clerk of the Madras Meteorological office and two by a subordinate clerk of the Bengal Meteorological office.

19. The following gives a comparative statement of the condition of the observatories inspected during the year and during each of the previous six years:—

Condition.	Number of observtories inspected in						
	1902-03.	1901-02.	1900-01.	1899-1900.	1898-99.	1897-98.	1896-97.
Very satisfactory	9	7	10	6	5	6	10
Satisfactory	46	54	43	27	33	20	39
Fair	21	12	33	19	19	13	14
Bad	10	9	13	5	5	5	9
Total	86	82	99	57	62	44	72

20. A large proportion of the observatories visited during the year were inspected in order to determine whether persistent errors in the observations telegraphed were due to instrumental changes or to careless observation. In the majority of cases the errors were found to be due to changes in the index errors of the instruments, but at the following seven stations, *viz.*, Bahraich, Maldah, Motihari, Rangpur, Barisal, Pamban and Buxar, they were found to be due to careless and inaccurate observation. Five of these observatories are in Bengal, where more frequent inspection appears to be necessary in order to secure satisfactory observations

21. The work of inspection is not yet so fully carried out as I should like to see it. Frequent inspection of observatories, more especially those located at hospitals, dispensaries and post offices, is absolutely essential, on account of the occasional changes of observers at short intervals necessitated by acting and other arrangements in the Medical and Postal Departments. Occasionally a half-time observer belonging to one of these departments is transferred at 24 hours' notice and his successor is compelled to take up the meteorological work without any training from his predecessor, and it is frequently impossible in such cases to make arrangements to inspect the observatory and train the observer till several weeks afterwards.

Storm Observations.

22. A comparatively small number of special observations of storms were sent in during the year 1902-1903, due in part to the comparative absence of cyclonic storms in India and in part to greater strictness in the assignment of rewards, which are now only granted for observations of real value for the investigation of the phenomena and distribution of the various classes of storms which affect weather in India. The great majority of those submitted were observations of the various classes of storms of the hot weather *i.e.*, thunderstorms, hailstorms and duststorms. About four hundred and twenty-seven sets of storm observations in all were sent in by 37 observers during the year 1902. In addition, a large number of special observations of various kinds were taken by certain observers for the information and use of the department, chiefly in connection with the work of storm and flood warning. For these storm and special observations amounts varying from one to sixty rupees were awarded.

Observations of special Meteorological Instruments.

23. The following special observations were carried out during the past year at certain selected stations:—

1st.—Wind observations recorded by Beckley's anemographs at seventeen stations and by Dines's pressure tube anemometers at twelve stations.

2nd.—Solar and terrestrial radiation observations at nine stations.

3rd.—Underground temperature observations at five stations.

4th.—Sunshine observations at six stations.

5th.—Barometric observations recorded by self-registering instruments, chiefly Richard Freres' barographs, at thirty-six stations (an increase of eight stations during the past year).

6th.—Thermometric observations recorded by self-registering instruments, chiefly Richard Freres' thermographs, at thirty-four stations (an increase of ten stations during the past year).

24. The only large additions during the past year to this class of work were under the fifth and sixth heads.

Richard Freres' barographs were supplied to Balasore, Cherra poonjee, Dodabetta, Gopalpur, Jaipur, Kodaikanal, Masulipatam and Periyakulam, and Richard Freres' thermographs to Balasore, Cherra poonjee, Cocanada, Dodabetta, Gopalpur, Jaipur, Kodaikanal, Madras, Masulipatam and Periyakulam.

Seismograph Observations.

25. Seismological observations were recorded for the Seismological Committee appointed by the British Association by means of Milne's self-registering seismograph during the year, as in previous years, at Alipore (Calcutta), Colaba (Bombay) and Kodaikanal. All the instruments worked satisfactorily throughout the year, and their records were regularly transmitted to the Seismological Committee of the British Association. Apparatus has also been introduced at Colaba to measure the vertical movement of the ground and its actual tilt. The working of the seismograph at Alipore was, in the year under review, quite satisfactory and its records of the chief disturbances were in accord with those of Colaba and Kodaikanal.

Marine Meteorology.

26. This work was carried out during the year under review in the same way as during the past nine years. One clerk of the Calcutta office was engaged during the year in collecting meteorological data from ships entering the Hooghly. He also made a careful comparison by means of secondary standards of the barometers on board the ships from which data were obtained, in order to ascertain the corrections to be applied to the barometric readings extracted from the logs of the vessels. The Bombay Meteorological office collected data from vessels entering the port of Bombay by the same methods as are employed at Calcutta. The data collected on each day are usually sent off by post to Simla on the following day, any portions that are required for the use of the Calcutta and Bombay offices being copied out without delay. Six logs were received during the year from the Port Officer, Rangoon.

27. The following table gives a statement of the work done under this head during the year, and the corresponding figures of the seven previous years, for comparison :—

		1902-1903.	1901-1902.	1900-1901.	1899-1900.	1898-99.	1897-98.	1896-97.	1895-96.
Calcutta	Number of logs extracted	1,164	1,168	1,322	1,302	1,284	1,325	1,140	1,135
	Number of barometric comparisons.	4,074	4,104	4,104	4,086	4,002	4,218	4,508	4,134
Bombay .	Number of logs extracted .	877	883	991	975	1,005	972	1,017	1,073
	Number of barometric comparisons.	3,938	4,127	5,470	3,900	5,904	5,881	6,197	6,018

28. The issue of Pilot charts giving, month by month, the normal meteorological conditions over the Indian seas, was continued. These charts show the mean pressure, the mean direction and force of the wind, the mean surface currents and the ordinary tracks of cyclones in the month under review. The chart for each month was issued about the 20th of the month preceding the period to which it referred. A small charge of

four annas was made for each copy. The total monthly issue amounts to about 120 copies.

Snowfall Registration in the Mountain Districts of Northern India.

29. The same methods were employed during the winter of 1902-1903 as in previous years to obtain full and accurate information of the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan Mountain areas. The information for the cold weather of 1902-1903 was, on the whole, fairly complete.

30. The thanks of the Department are due to the various officers who have collected and forwarded snowfall information during the past winter and more especially to the Deputy Conservators of Forests of the Chamba and Bushahr Divisions, the Meteorological Reporter, Kashmir State and the district officers of Kangra and the frontier districts for information of special accuracy and value.

Rainfall Registration.

31. No change was made in the system or methods of rainfall registration during the year under review. A full account of the methods employed, which came into full operation during the year 1891-92, will be found in pages 5—8 of the Administration Report of the year 1889-90, and pages 6—7 of the Administration Report of the year 1890-91.

32. The following gives a classified statement of the number of rain-gauge stations of which inspection reports were received by the India Meteorological office during the year 1902-1903, and the total number of rain-gauge stations at the end of the year in the various political divisions of the empire :—

Province or Division.	Number of rain-gauges on 31st March 1903.	Number of rain-gauges reported as inspected in 1902-03 (classified).				Percentage of inspections reported to total number of rain-gauges.
		Good	Fair.	Bad.	Total.	
Baluchistan	53					
Kashmir	37					
Punjab and North-West Frontier Province.	220	45	7	2	54	25
United Provinces of Agra and Oudh.	277	33	8	1	42	15
Bengal	374	89	20	4	113	30
Assam	118	37	14	2	53	45
Burma	152	45	7	1	53	35
Central Provinces	86	107	11	1	119	138
Berar	44	70	16	—	86	195
Central India	71					
Rajputana	155	10	—	—	10	6
Bombay and Sind	283					
Hyderabad	23					
Mysore	77					
Madras (including Pudukota, Coorg, Travancore and Cochin)	459	281	71	12	364	79
Total	2,429	717	154	23	894	37

LIBRARY

33. The registration of rainfall in India has invariably been carried out by the Provincial authorities and in the larger provinces under the general control of the Boards of Revenue. Previous to 1889 the hours and arrangements for the registration of rainfall differed largely in different provinces. In 1889 a uniform system was introduced by the Government of India, and the Meteorological Reporter to the Government of India was made consulting officer in connection with this work. The local officers superintending the registration of rainfall submit brief annual administrative reports to their respective Governments, copies of which are forwarded to the Imperial Meteorological Reporter.

34. The following paragraphs give a brief summary of the reports on rainfall registration for the year 1902-03 submitted to the various Local Governments and Administrations by these local officers :—

35. *Assam.*—The number of stations on the 31st March 1903 was 118 (56 under Government and 62 under private management). Three new stations were opened and one was given up during the year.

On the whole the work of inspection was well done, only 31 stations remaining unvisited as compared with the same number in the previous year. The best returns came from Kamrup, Nowgong, the Lushai Hills and Sylhet, but in Darrang, Lakhimpur, Cachar and Sibsagar, the proportion of gauges that escaped inspection was unduly large.

36. *Bengal.*—The number of rain-gauge stations on the 31st March 1903, was 374, *i.e.*, 8 more than on the corresponding date last year. Ten stations were started and two closed.

The number of visits of inspection made during the year was 415, against 300 during 1901-1902. The total number of rain-gauges inspected was 232, against 177 in the previous year. The reports received from the inspecting officers showed that the rain-gauges were for the most part in good condition and the rainfall registers properly kept.

37. *Berar.*—No change was made during the year in the number of rain-gauge stations.

The number of inspections made during the year under review was in excess of the required amount in the Akola and Ellichpur districts. In the Amraoti, Basim, Buldana and Wun districts the requisite number of inspections were made. The only station unvisited was in Ellichpur: the omission is explained as due to frequent changes of officer.

38. *Bombay.*—Report not received.

39. *Burma.*—Three registering stations were opened during the year, making 152 as the total number of stations recording rainfall at the close of the year.

Of the 145 rain-gauges inspected, 123 were found in good condition, 20 in a fair state and two were bad. In two, the registration was found to be defective owing to the ignorance of the clerk. In eighteen cases the gauge was placed in an unsuitable position. The Okpo station of the Tharrawaddy district was transferred to Minhla in the same district.

40. *Central Provinces.*—The number of rain-registering stations is 76, in addition to 10 observatories of the Meteorological Department: no new station was established, nor was any abolished during the year. The number of inspections of rain-gauge stations during the year was 106 as against 94 in the preceding year and 63 in the year 1900-01. All defects reported received attention and the results obtained during the year are reported as satisfactory.

41. *Madras.*—On the 31st March 1902, there were 427 rain-recording stations, excluding 26 meteorological observatories, furnishing rainfall returns for publication in the *Fort St. George Gazette.* To these 7 were added and one was closed during the year, making the total 433 at the end of the year. Of this total, 372 are in the Madras Presidency and of these 333 were inspected during the year or 90 per cent. of the total number. There was great improvement in the inspection in the North Arcot district, but in the

Nilgiris only 2 out of 9 were inspected. In the native states only 7 stations were inspected out of 61.

All the defects in the Inspection Reports sent in during the year have been or are being rectified. In January 1903 a list of rain-gauges in each district not inspected or reported on since 1st April 1902 was sent to the Collector of that district, with a request that, if possible, these gauges should be inspected before the end of the official year.

42. *North-West Frontier Province.*—No report received.

43. *Punjab.*—There was no change in the number of rain-registering stations during the year, which, as last year, stands at 189.

The total number of inspections made by Revenue Officers in the Punjab, and reported to this office, was 76 or about 40 per cent. of the whole, as against 51 reported in the previous year. No reports of any inspections having been made during the year have been received from the Commissioners of Delhi and Lahore Divisions, and the Deputy Commissioners of Gurgaon, Delhi, Simla, Hoshiarpur, Jullunder, Ludhiana, Jhang, Dera Ghazi Khan, Lahore, Gujranwalla, Jhelum and Shahpur districts. It is probable that these officers may have made some inspections but have omitted to report the fact.

The reports received from the officers of the Canal Department show that the rain-gauges under their charge have been regularly inspected from time to time during the year by Executive and Assistant Engineers and that the gauges have been maintained in good order.

The rain-gauges in the Punjab, are in the opinion of the Director of Land Records, in good order and the rainfall records properly kept.

44. *United Provinces of Agra and Oudh.*—There are 290 rain-reporting stations in these Provinces, including the meteorological observatories and two duplicate stations in the Meerut District.

Regular and complete reports of inspections were received from twelve districts. The work of inspection was only partially carried out in the remaining 36 districts.

No reports of inspections were received during the year from five districts; and in eight districts only one station in each was inspected.

One hundred and sixty-two stations, or nearly 56 per cent. of the whole, were reported as inspected during the year, 26 of them having been inspected more than once. This proportion is slightly higher than was reached last year.

45. ***Summary.***—The work of rainfall registration is steadily improving and is now satisfactorily carried out over nearly the whole empire.

The work of inspection was best done in Berar, Assam and Madras and has improved considerably in Bengal and Burma. No increase of inspection was made in the United Provinces of Agra and Oudh. The steady improvement in this important branch of meteorological work in Bengal and Burma is very creditable to the officers in charge of the rainfall registration in these two provinces.

SEASONAL FORECASTS.

46. The forecast of the probable character of the rainfall during the south-west monsoon of 1902 was issued confidentially in the same form as in the preceding eleven years under the heading of "Memorandum on the snowfall in the mountain districts bordering Northern India, and the abnormal features of the weather in Indian monsoon area during the past year with a statement regarding the probable character of the south-west monsoon rains of 1902."

47. The following gives the statement of the forecast, as published in this memorandum :—

"(1) *that the monsoon currents will not be above their normal strength and may fall below it;*
(2) *that there will be no very abnormal delay in the establishment of the currents on either side of India, which may therefore be expected about the middle of the second week of June on the Bombay Coast and by the third week of June on the Bengal Coast;*

(3) *that the West Coast current will appear more nearly simultaneously than usual at all parts of the Coast and advance somewhat more rapidly than usual inland;*

(4) *that the Arabian Sea current is more likely to give good rain than the Bay current, but that both are likely to be less steady than usual during June;*

(5) *that the average rainfall of the whole of India may be in slight defect.*"

48. The following inferences respecting the distribution of the south-west monsoon rains of 1902 in India are deduced from a comparison of the antecedent conditions of that year with those of previous years :—

"(1) Conditions are generally unfavourable in Burma, more especially in Upper Burma. The rainfall of the period will hence probably be normal or in slight defect in Lower and Central Burma and in moderate defect in Upper Burma.

(2) Conditions are as unfavourable in Assam as in Upper Burma and it is probable that on the mean of the monsoon period the rainfall will be below the normal to a moderate extent in that area.

(3) Conditions are slightly unfavourable in East and North Bengal and the rainfall there will probably be in slight defect. In Orissa, Chota Nagpur and West Bengal, however, conditions are favourable for at least normal rainfall.

(4) Conditions are favourable in Bihar and the United Provinces and these districts will, as a whole, probably receive at least normal rainfall.

(5) Conditions are, on the whole, favourable in the Punjab, and it is probable that the monsoon rainfall of the present year will be about normal in the East Punjab but below the normal to a moderate extent in the western and northern districts where conditions are more or less unfavourable. If the monsoon currents prove strong, conditions are favourable for unusually heavy rain in the Simla and Mussoorie hills and the adjacent sub-montane districts.

(6) Conditions are almost as favourable in Central India as in the United Provinces, and that area will probably receive about normal rainfall. The rainfall is more likely to be in excess in the eastern than in the western states.

(7) Conditions are, on the whole, favourable in Rajputana—more specially in the eastern and central districts, where the monsoon rainfall will hence probably be normal.

(8) Conditions are, on the whole, favourable in the Central Provinces. It is hence probable that this area will receive normal rainfall. The conditions are slightly more favourable in the eastern than in the western districts, and it is hence probable that the eastern districts may receive rainfall in slight excess of the normal. They are less favourable in Hyderabad than in the Central Provinces, and the rainfall in that state will probably be normal or in slight defect.

(9) Conditions are practically normal in Berar and Khandesh, and the rainfall in these areas will probably be about normal. They are, on the whole, favourable in the West Deccan and that area will probably receive its normal fall.

(10) The conditions in the West Coast districts are, on the whole, such as are, in years of normal monsoon conditions usually associated with normal rainfall. It is hence probable that the rainfall of the present year's south-west monsoon will be about normal on the Konkan coast. It is probable that it will be slightly below normal in Malabar, where conditions are less favourable.

(11) The variations of the rainfall in the North Madras Coast districts are in at least five years out of six similar to those of Orissa and the Central Provinces. Conditions appear to be, therefore, on the whole, favourable, and it is probable that those districts will receive about normal rain.

(12) A comparison of the conditions in the Madras Deccan, Mysore and the Carnatic with those of similar years indicates that the rainfall during the period—June to September —will probably be in slight excess in Mysore and South Madras and normal or in defect in Central and East Madras. If, however, a prolonged break in the rains occurs in Northern India in July or August, South India will receive abundant rain.

(13) The pressure conditions in Gujarat, Kathiawar, Sind and Cutch are such as are usually associated with deficient rainfall. Hence in these areas less rain than usual may be expected. If the Bombay current proves weaker than usual the deficiency in these areas may be serious.

(14) It should be carefully borne in mind that in 1880, a year with pre-monsoon conditions very closely resembling those of the present year, a heavy and untimely fall of snow occurred in the North-West Himalayas in July, which was followed by a prolonged break lasting throughout the greater part of August. Thus although conditions at the end of May were then, as now, favourable for rain in the Punjab, this untimely and unpredictable fall of snow in July seemed sufficient to check the currents for the greater part of a month and thus cause a serious deficiency in the season's total rainfall. The possibility of a similar occurrence in the present year must, therefore, be kept in view."

49. The following table gives rainfall data of the south-west monsoon of 1902 for fourteen political divisions for comparison with the forecast :—

Province or Division.	Rainfall of Season June to October.			
	Average actual, 1902.	Average normal.	Variation of actual from normal, 1902.	Percentage variation from normal, 1902.
	Inches.	Inches.	Inches.	
Burma	94·75	98·01	−3·26	− 3
Assam	81·81	77·83	+3·98	+ 5
Bengal	66·59	62·53	+4·06	+ 6
Chota Nagpur	41·01	44·71	−3·70	− 9
Bihar	40·87	44·61	−3·74	− 8
United Provinces of Agra and Oudh	32·67	35·88	−3·21	− 9
Punjab	13·24	14·81	−1·57	−11
Baluchistan	2·15	2·16	−0·01	0
Central Provinces	33·60	45·99	−12·39	−27
Central India	33·24	35·56	−2·32	− 7
Rajputana	15·35	16·63	−1·28	− 8
Berar	25·20	29·61	−4·41	−15
Bombay	37·16	40·54	−3·38	− 8
Madras	40·08	34·05	+6·03	+18

50. The forecast was not quite satisfactory as the prolonged weakness of the Arabian Sea current until the middle of August was not anticipated. The general distribution of the rainfall, as indicated by the forecast, was, on the whole, in moderate accordance with facts except in the cases of the Central Provinces and Berar where the rainfall was in considerable to large defect and in a part of which the crops failed, due chiefly to deficient rainfall and the early termination of the monsoon rains.

51. The following is the forecast of the winter rains of 1902-03 (*i.e.*, from December 1902 to February 1903), as issued in the third week of December 1902 to the Government of India :—

(1) The winter precipitation in Persia and Baluchistan will very probably be above the normal, probably to a large extent in Persia and to a considerable or moderate extent in Baluchistan.

(2) The snowfall in the Punjab Himalayas and the Afghan Mountains will very probably be at least normal and probably in moderate to large excess over the greater part of the area.

(3) The vertical anomalies at Darjeeling are almost certainly incorrect due to some error of observation or of instrument, and hence it is not possible to forecast the character of the snowfall over the Eastern Himalayas.

(4) The winter rains (due to cold-weather storms originating in the Persian area) in Upper India, *i.e.*, the Punjab, Sind and Rajputana from December to February, will very probably be at least normal and probably be in moderate to largish excess.

(5) It is very probable that the winter precipitation in the Gangetic Plain due to the same causes will be at least normal and probably in moderate excess.

(6) There are, so far as can be judged from the data, no special features of importance in the meteorological conditions of Central India and the Central Provinces. It is hence probable that these areas will receive at least normal rainfall.

(7) The indications of an early commencement of the winter rains in the plains of Upper or Central India are very slight and it is very probable they will not commence before the fourth week

of December. There is also a slight probability, indicated chiefly by a comparison with the cold-weather period of 1888-89, that they may be delayed until the middle of January and that the depressions in the first half of January will give little rain in the plains of North Western India. There is hence also a slight probability from comparison with similar years that the precipitation may be heavier in February than January.

(8) To sum up. The indications are generally very favourable for normal to abundant precipitation over the whole of North-Western and Central India and for heavy snowfall over the Western Himalayas, more especially in the middle and higher elevations.

52. The following statement gives comparative rainfall data of the larger provinces of Northern and Central India for the period December 1902 to February 1903 :—

Province or Division.	Rainfall of period, December to February.			
	Average actual, 1902-03.	Average normal.	Variation of actual from normal.	Percentage variation from normal.
	Inches.	Inches.	Inches.	
Assam	1·60	2·65	—1·05	— 40
Bengal	1·49	1·44	+0·05	+ 3
Chota Nagpur	1·67	1·54	+0·13	+ 8
Bihar	0·40	1·37	—0·97	— 71
United Provinces of Agra and Oudh	0·47	1·69	—1·22	— 72
Punjab	0·79	2·47	—1·68	— 68
Baluchistan	1·70	3·84	—2·14	— 56
Central Provinces	1·02	1·17	—0·15	— 13
Central India	0·38	1·28	—0·90	— 70
Rajputana	0·16	0·74	—0·58	— 78
Berar	1·90	0·80	+1·10	+138
Bombay	1·57	0·36	+1·21	+336
Madras	5·57	2·55	+3·02	+118
Burma	0·60	0·51	+0·09	+ 18

53. The forecast of the cold weather rainfall of 1903 was less satisfactory than that of the preceding year. The character of the winter snowfall in the Western Himalayas and the delay in the commencement of the cold weather rains were correctly gauged. The rainfall in North-Western and Central India was much less than anticipated and was only partially compensated by rainfall in March, due to the continuance of cold weather conditions in that month.

Storm Warnings.

54. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed by two officers. Ports on the Bay of Bengal are warned from the Calcutta Office by the Meteorological Reporter to the Government of Bengal, and ports on the Arabian Sea Coast from the Simla Office by the Meteorological Reporter or Assistant Meteorological Reporter to the Government of India.

The present system of storm signals was brought into operation on the 1st April 1898.

The complete system at present in operation includes :—

1st.—An extended system of storm signals for use at the larger and more important ports.

2nd.—A brief system of storm signals for use at the smaller ports, chiefly for information of native or country vessels.

55. ***Bay of Bengal Storm Signal Service.***—The following gives a list of the ports which were warned during the year 1902-03 by the Meteorological Reporter to the Government of Bengal:—

(*a*) *Burma Ports*—	(*b*) *Bengal Ports*—	(*c*) *Madras Ports*—
Mergui.	Calcutta and River Hooghly.	Gopalpur.
Tavoy.	Narayanganj.	Bimlipatam.
Moulmein.	Chittagong.	Vizagapatam.
Rangoon.	Orissa Ports, including Puri,	Cocanada.
Bassein.	False Point, Chandbali and	Masulipatam.
Akyab.	Balasore.	Madras.
		Negapatam.
		Pamban.
		Tuticorin.

The following gives the arrangement of the ports according to the method of warning adopted:—

BAY OF BENGAL PORTS.

I.—By extended system.			*II.—By brief system.*
Tavoy.	Calcutta and River Hooghly.	Cocanada.	Narayanganj.
Moulmein.	False Point.	Masulipatam.	Balasore.
Rangoon.	Puri.	Madras.	Chandbali.
Bassein.	Gopalpur.	Negapatam.	
Akyab.	Bimlipatam.	Pamban.	
Chittagong.	Vizagapatam.	Tuticorin.	

Telegraphic information is also sent to Chittagong, Narayanganj and the Orissa ports whenever storm signals are hoisted at Saugor Island. This extension was suggested by the Government of Bengal in May 1898.

It may be noted that in the case of the Bengal ports, the signals are hoisted by the direct orders of the Meteorological Reporter to the Government of Bengal. In the cases of the Burma and Coromandel Coast ports, the storm signals are hoisted by the orders of the port officers, acting on information respecting the path and intensity of the storms received at short intervals during their progress from the Meteorological Reporter to the Government of Bengal.

The Bay of Bengal ports were visited by eleven storms or disturbances for which storm signals were hoisted. The Bay was unusually free from storms in June and also in November and December. A small but severe storm crossed the Lower Pegu Coast in the first week of May. It caused much damage in the Rangoon River. The S. S. *Camorta* with 600 passengers and the S. S. *Hermod* went down off the Burma Coast. A succession of four storms formed in the north of the Bay between the middle of August and the end of September. They were of slight to moderate intensity. Two storms formed in October, of which one advanced to the Bengal Coast and the other to the Madras Coast. They were only of slight intensity.

There are also certain special arrangements at Calcutta for supplying the latest weather information by means of flag-signal hoist messages to certain ports of the Bay for the information of outward-bound shipping when passing Saugor Island, and for obtaining early information of the weather at the head of the Bay from vessels entering the Hooghly. These arrangements worked satisfactorily throughout the year, and occasionally gave information of much value to the mail and coasting steamers of the British India and other shipping companies.

56. ***Bombay Storm Signal Service.***—The work of warning the Bombay ports was carried out during the past year by the Simla Meteorological Office under the arrangements introduced in September 1889, and fully stated in pages 17 and 18 of the

Administration Report of 1889-90. The Simla Office also warned the Madras ports on the Malabar coast in the same manner as the Bengal Reporter warned the Madras ports on the coast of the Bay of Bengal. Warnings of storms in the Arabian Sea were also sent to the Port Officer, Aden, for the information of steamers leaving that port for Colombo, Bombay and Kurrachee. Copies of all warnings sent to the Malabar ports were forwarded to the Master Attendant, Colombo, for information.

The following is a list of the Bombay and Malabar ports warned under this system during the year 1902-03 by the Simla Meteorological Office :—

(*a*) *Bombay Ports.*			(*b*) *Malabar Ports.*
Kurrachee.	Daman.	Mormugao.	Mangalore.
Cutch-Mandvi.	Bombay.	Goa.	Tellicherry.
Jamnagar.	Alibag.	Vengurla.	Calicut.
Dwarka.	Murud Janjira.	Karwar.	Cochin.
Porbandar.	Ratnagiri.	Kumta.	
Veraval.	Malwan.	Honavar.	
Jafrabad.			
Bhavnagar.			

The following gives the arrangement of the ports according to the method or system of storm signals adopted :—

ARABIAN SEA PORTS.

I.—By extended system.	*II.—By brief system.*	
Kurrachee.	Cutch-Mandvi.	Ratnagiri.
Bombay.	Jamnagar.	Malwan.
Mormugao.	Dwarka.	Vengurla.
Mangalore.	Porbandar.	Goa.
Tellicherry.	Veraval.	Karwar.
Calicut.	Jafrabad.	Kumta.
Cochin.	Bhavnagar.	Honavar.
	Daman.	
	Alibag.	
	Murud-Janjira.	

Weather was exceptionally stormy in the Arabian Sea during the year. At least five storms of considerable intensity affected that area during the year, the largest number on record. The first storm which occurred during the first week of May was generated in the centre of the Arabian Sea and advanced by a curved track to the Sind Coast. It was of great intensity and caused the total loss of the *S. S. Ehrenfels* to the east of Socotra. The second storm formed in front of the advancing monsoon in the second week of June. It was also a fierce storm and gave a storm wave on the Sind Coast near Kurrachee which caused much destruction in that port. The remaining storms were initiated during the retreating south-west monsoon period. Two of them, those of October, advanced up the centre of the sea to the Arabian Coast. The third marched slowly and broke up when approaching Kathiawar.

57. The storm warning work was, on the whole, carried out stisfactorily by the warning officers at Simla and Calcutta. Ample and early definite warning was, so far as I can judge, given in the case of all the more important storms which visited the coasts of India in 1902-03, except perhaps the storms of the first week of May which formed and advanced so rapidly to the Sind and Burma Coasts that it was not possible with the present arrangements to give as early warning to the ports affected as was desirable.

It may also be noted that the storm in the Arabian Sea was of very small extent and

the observations at the coast stations gave no indication of its existence until it was in the immediate neighbourhood of the Sind Coast.

FLOOD WARNINGS AND WEATHER FORECASTS TO DISTRICT OFFICERS, IRRIGATION AND OTHER OFFICERS OF THE PUBLIC WORKS DEPARTMENT AND TO EXPEDITIONS IN THE FIELD.

58. This work is chiefly carried out by the Simla Meteorological Office. The arrangements for it have been sanctioned at various times, and differ considerably in character, depending upon the nature and extent of the flood or weather warnings required by the officers concerned. The common feature of the work is that individual officers receive special warning telegrams when necessary, in order to enable them to take precautionary measures for the safety of the works or of the district under their charge.

59. Warnings of heavy rain likely to give rise to serious floods in the Nerbudda, Tapti, Sabarmati or Mahi rivers are sent to twelve officers in the districts of Gujarat, Kathiawar, Bombay and Khandesh. Telegrams are sent by the Simla office warning these officers of the existence of storms likely to give heavy rain and severe floods, and the meteorological observers at Hoshangabad, Jubbulpore, Khandwa, Pachmarhi, Amraoti, Akola and Chikalda telegraph directly to the same officers the actual occurrence of heavy rain at their respective stations.

60. The arrangements by which weather and flood warning telegrams are sent to certain Public Works, Railway and Irrigation officers were fully stated in pages 30—31 of the Administration Report for 1889-90. In some cases, the officers concerned require telegrams warning them of advancing storms likely to give heavy rain; in other cases, they require telegrams giving information of actual heavy rainfall in the hill districts likely to give rise to severe floods which might injure the railways or canal works in the submontane districts under their charge; and in others, they require warnings or forecasts of the weather for as long a period beforehand as possible, so as to enable them to modify their arrangements for carrying on the works under their charge, so far as may be necessitated by sudden or large changes of weather.

61. The number of district officers and officers in the Irrigation, Railway and Public Works Departments requiring warnings amounted at the end of the year to 68.

62. The list of officers warned does not include captains of mail steamers and other vessels who occasionally telegraph from Kurrachee, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

63. Seven hundred and fifty-nine special warning messages were sent last year, as compared with 745 in 1901-02 and 509 in the year before.

64. Warnings of floods or of heavy rainfall were issued by the Bengal Reporter to seventeen officers of the Public Works and other Departments, chiefly in the province of Bengal.

65. Instructions were issued four years ago by the Government of India that every officer to whom storm or flood warnings are issued, should in the month of January of each year or, in the case of military expeditions, at the close of the campaign, forward to the Meteorological Reporter to the Government of India a brief return of the warnings received during the past year and should also report:—

(1) Whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

(2) Whether the warnings were timely and satisfactory in every respect, and, if not, in what points they were defective.

(3) Whether any changes might be made in the system which would make the warnings more useful and effective.

66. Opinions were received in all from 45 officers. Forty-one officers stated that the

warnings they had received were timely and satisfactory and that they had no suggestions to make for the improvement of the system. The Port Officer, Balasore, complained of the delay in the transmission of the warning telegrams. The Executive Engineer, Rawalpindi, the Superintending Engineer, Indus Left Bank Division and the Chief Engineer, Indus Right Bank Division, pointed out that the warnings of heavy rain and floods sent to them during the year were not received in time to be of much practical value.

67. Every effort is being made to improve the flood warning telegrams, but in some districts in India, more especially the Punjab, it is very difficult to forecast with approximate accuracy the occurrence of heavy rain more than 12 to 24 hours before its actual occurrence.

PUBLICATIONS.

A.—WEATHER REPORTS.

68. ***India Weather Reports.***—The following weather reports, giving information of the current weather to the Government and the Public, were published during the year by the India Meteorological office:—

(1) India Daily Weather Report and Chart.
(2) India Weekly Weather Report, giving an account of the weather and of the rainfall of the week ending on the previous Thursday, published in the *Gazette of India* every Saturday.
(3) India Monthly Weather Review, giving a general summary and a full review of all the important features of the weather and complete meteorological data of the month.

India Daily Weather Report and Chart.—The number of stations for which data were given in the daily report of the 31st of March 1902 was 161 and in that of the 31st March 1903, 164.

The daily weather report was issued on March 31st, 1903 to 435 recipients or 8 more than on the same date in the previous year.

India Weekly Weather Report.—The Weekly Weather Report was published in the *Gazette of India* in the same form as in the previous year. An additional brief summary of rainfall conditions was sent by wire to the Revenue and Agricultural Department, Government of India, on Wednesdays from the 5th November 1902 up to the 3rd of December 1902, for use in the preparation of the famine telegram transmitted to the Secretary of State. Additional and special information in the shape of weekly rainfall statements was supplied to the Revenue and Agricultural Department for certain districts in Bombay, the Central Provinces, Rajputana and Hyderabad (Deccan) for the period from 1st June to 11th October 1902, where the rainfall, during a considerable part of the monsoon period, was very scanty, and drought and famine conditions were hence feared.

India Monthly Weather Review.—A section has been introduced describing the condition of the crops during the month. This is compiled from the weekly season and crop reports published in the *Gazette of India.* A second section describing the chief solar and magnetic (terrestrial) disturbances based on information received from the Kodakanal and Colaba observatories was also added. These sections first appeared in the Review for January 1903.

The following gives the dates of issue of the parts of the Monthly Weather Review for the past year:—

	Date of Issue.				*Date of Issue.*	
April	1902.	25th September	1902.	October	1902	9th March 1903.
May	,,	25th November	,,	November	,,	31st March ,,
June	,,	12th December	,,	December	,,	24th April ,,
July	,,	10th January	1903.	January	1903	19th June ,,
August	,,	28th January	,,	February	,,	29th June ,,
September	,,	27th February	,,	March	,,	14th August ,,

Annual Summaries.—The annual summary of the meteorology of India for 1901, supplementing the Monthly Weather Reviews for that year, was issued on the 26th March 1903. It contains mean data for the year 1901 and a discussion of the more important meteorological features of the year and of their relations to each other. A summary of the meteorology of the year 1901 was prepared for the Sanitary Commissioner with the Government of India, and was given as Chapter I of the Annual Report of that officer for the year 1901.

Special Charts.—The Simla Office prepared, throughout the year, weekly charts (drawn by hand) showing the actual and normal rainfall of each week and the actuals and normals of the seasonal rainfall up to date, for the use of His Excellency the Viceroy, His Majesty's Under-Secretary of State for India, London, and the Secretary to the Government of India in the Revenue and Agricultural Department. Similar charts were also forwarded to the Lieutenant-General Commanding the Forces in Bengal, Naini Tal, from the middle of August 1902.

The Calcutta office of the India Meteorological Department prepared four series of average seasonal rainfall charts and annual rainfall charts of the whole of India, as in previous years, for the information of the Government of India and the Secretary of State.

69. ***Provincial Weather Reports.***—The following provincial reports were issued by the provincial Reporters during the year :—

(1) By the Bengal Reporter—

(*a*) Bay of Bengal Daily Weather Report and Chart issued during April, November and December 1902, and January to March 1903.

(*b*) Bengal Daily Weather Report and Chart issued during the period May to October 1902.

(*c*) Monthly Rainfall Table for Bengal and Meteorological Table for Bengal and Assam, with a summary of the chief features of the weather of the month published in the *Calcutta Gazette.*

(*d*) Report on the meteorology of Bengal for the monsoon season of 1902, illustrated with rainfall maps.

(*e*) A short annual report on the meteorology of Bengal for the year 1902, illustrated with rainfall maps, was prepared during the official year and submitted to the Government of Bengal on April 4th, 1903.

(*f*) Charts showing the distribution of actual rainfall, the variation from the normal and the percentage variation, were prepared monthly during the period May to October 1902, and submitted to the Government of Bengal and the Sanitary Commissioner, Bengal.

(2) By the Bombay Reporter—

(*a*) Bombay Daily Weather Report and Chart.

(*b*) Monthly abstracts of meteorological observations published in the Bombay Government *Gazette.*

(3) By the Madras Reporter—

(*a*) Madras Daily Weather Report and Chart.

(*b*) Monthly Rainfall Table for Madras, Coorg, Pudukota, Cochin and Travancore published in the Provincial *Gazette.*

(4) By the Meteorological Reporter to the Government of the United Provinces of Agra and Oudh—

(*a*) Monthly Weather Summary of the province published in the Provincial *Gazette.*

(*b*) Brief sketch of the meteorology of the province for the year 1901-02.

(*c*) Monthly Rainfall Table for the United Provinces of Agra and Oudh, published in the Provincial *Gazette.*

(5) By the Meteorological Reporter for the Punjab—

(*a*) Monthly summary of the weather of the Punjab, published, in the Provincial *Gazette*.

(*b*) Annual meteorological summary of the Punjab for the year 1901-02.

(*c*) Meteorological and climatological statement of the Punjab for the *Imperial Gazetteer*.

(*d*) Meteorological and climatological statement of the North-West Frontier Province for the *Imperial Gazetteer*.

B.—Indian Meteorological Memoirs.

70. The following were issued during the year :—

(1) Discussion of results of the hourly observations recorded at twenty-nine stations in India, given in Volumes V, IX and X. of the Indian Meteorological Memoirs, (Final chapter and plates) by the Meteorological Reporter to the Government of India and Director-General of Indian Observatories (Indian Meteorological Memoirs, Vol. XII, Part III).

(2) Meteorological history of the seven monsoon seasons 1893-99, in relation to Indian rainfall, by W. L. Dallas, Scientific Assistant to the Meteorological Reporter to the Government of India. (Indian Meteorological Memoirs, Vol. XII, Part IV).

(3) Rainfall of India giving the registered monthly rainfall of 457 stations for various periods ending with December 1900, and also the monthly and annual means. (Indian Meteorological Memoirs, Vol. XIV).

71. The following are now in the press and will be issued during the year 1903-04 :—

(1) Summary and a brief discussion of observations of the clouds recorded at six stations in India, during the period 1895-1900, by the Meteorological Reporter to the Government of India and Director-General of Indian Observatories.

(2) Report on cloud observations and measurements at Simla during the period June 1900 to January 1902, by W. L. Dallas, Scientific Assistant to the Meteorological Reporter to the Government of India.

(3) Monthly normals of air pressure reduced to 32° F and constant gravity, Lat. 45°, by the Meteorological Reporter to the Government of India and Director-General of Indian observatories.

C.—Other Publications.

72. The following were issued during the year :—

(1) A new edition of the "Instructions to observers of the Indian Meteorological Department."

(2) The rainfall of India for the year 1901. This gives rainfall data of about 2,250 stations. It is published in two forms, one giving daily rainfall data for the raingauge stations in all parts of India, and the other monthly rainfall data.

Meteorological Offices.

73. The India Meteorological office and the Alipore Central Observatory, are now located in buildings in the same compound at Alipore, an arrangement which has considerably improved the character of the work in both offices. The Simla Meteorological office which forms virtually a part of the Central office, issues the India Daily Weather Report and the India Weekly Weather Report and carries out an increasing amount of the ordinary current and special work of the head office, such as preparing data for the Monthly Weather Reviews, for the annual summary and for special memoirs.

74. In addition to the Imperial Meteorological offices at Alipore (Calcutta) and Simla, there are Provincial Meteorological offices at Allahabad, Bombay, Calcutta and Madras.

LIBRARY.

75. Six hundred and twenty-five books and pamphlets were added to the Library during the year which were either purchased or presented by scientific bodies. The Library is in good order.

76. Seven libraries and foreign observatories and societies were added during the year 1902-03, to the list to which the publications of the India Meteorological Department are supplied, bringing the number on the list up to 345.

CONCLUDING REMARKS.

77. The Meteorological Department received valuable assistance in its work from the Survey, Telegraph and Postal Departments during the year.

78. The Telegraph Department has continued to assist the Department by the rapid transmission of storm and flood-warning telegrams during the year. There are in all twenty-eight observatories established at Departmental Telegraph Offices, the observations being taken either by the telegraph master or by a signaller, and all worked satisfactorily during the year except Akyab.

79. By permission of the Postal Department, meteorological observatories have been established at seventeen combined Postal and Telegraph Offices. Observations at the great majority of these stations are taken by one of the telegraph signallers, but in one or two cases they are recorded by the postmasters. All these observatories, with the exception of Bahraich, worked satisfactorily during the year.

80. Daily weather telegrams from Aden were sent free of charge to Bombay by the Eastern Telegraph Company during the year, and were thence forwarded as ordinary service weather telegrams to Simla, where they usually arrived, during the year, about an hour-and-a-half after despatch from Aden. The Department is greatly indebted to the Eastern Telegraph Company for this valuable concession,.

81. The observatories at Jask, Teheran and Ispahan, at the telegraph offices of these stations on the Indo-European telegraph line, furnished valuable observations during the year. Daily weather telegrams were transmitted, free of cost, to the Department to Kurrachee from Bushire and Jask throughout the whole year, and from Ispahan and Teheran throughout the cold weather from the 16th of November 1902 to the 29th of April 1903. These telegrams were forwarded from Kurrachee to Simla in the same manner as ordinary Indian weather telegrams. They were very useful in forecasting the approach of cold weather storms from Persia to Northern India. The Department is greatly indebted to the Directors of the Persian Gulf Section and the Persian Section for the continuance of this most valuable concession during the year.

82. Weekly telegrams were received during the south-west monsoon period from the departmental observatories at Zanzibar and the Seychelles and also from the Royal Alfred Observatory, Mauritius. These telegrams gave valuable information during the south-west monsoon period of the weather conditions in the Indian Ocean and the department is indebted to the officers for their punctual transmission of the telegrams and more expecially to the Director of the Royal Alfred Observatory, for his courtesy in placing the meteorological data of that observatory at the disposal of the India Meteorological Department.

83. The Department is greatly indebted for very important information as to the meteorological conditions in South Africa antecedent to the south-west monsoon, to Mr. Hutchins, Conservator of Forests, Cape Colony, and also for special information, to the Public Works Department, Cairo, to Clement Wragge, Esqr., Government Meteorologist, Brisbane, Australia, and J. McClounie, Esq., head of the Scientific Department, Zomba, British Central Africa. The information received was utilized in the preparation of the south-west monsoon forecast issued in the first week of June.

84. The co-operation of the Provincial Reporters, more especially Messrs. Dallas,

Murray, Jones, and Kenyon and of Mr. Küchler, Assistant Meteoroiogical Reporter, in charge of the Central Observatory at Alipore, has contributed largely to the progress of the Department during the past year.

85. Mr. W. A. Bion, First Assistant, and Lala Hem Raj, Second Assistant, in the India Meteorological office, Simla, have both done excellent work throughout the year.

86. I desire to place on record the names of the following subordinate officers in the Simla and Calcutta Meteorological offices, who have done good service during the past year :—

(1) Rai Sahib Fanindra Mohan Basu, Head Clerk of the Calcutta Central Meteorological office.

(2) Babu Allah Bakhsh, Head Clerk of the Simla Meteorological office.

(3) Babu Nirduksha Kumar Ghosh, Chief Computer of the Calcutta Central Meteorological office.

(4) Babu Nirbhai Singh, Computer of the Simla Meteorological office.

JOHN ELIOT,

Meteorological Reporter to the Government of India and Director-General of Indian Observatories.

METEOOGAL OFFICE, INDIA;
Alipore (Calcutta) the 29th June 1903.

REPORT

ON

THE ADMINISTRATION

OF

THE METEOROLOGICAL DEPARTMENT

OF

THE GOVERNMENT OF INDIA

IN

1903-1904.

DEPARTMENTAL CHANGES DURING THE YEAR 1903-04.

Retirement of Sir John Eliot and appointment of Mr. Gilbert T. Walker as head of the Department.

1. After a service of 35 years in India, of which the latter half was devoted to the direction of meteorological observation and research Sir John Eliot retired on 31st December 1903. He became Meteorological Reporter to the Government of the North-Western Provinces in November 1874, Meteorological Reporter to the Government of Bengal in March 1876, and was made Officiating Meteorological Reporter to the Government of India in May 1887 in place of Mr. Blanford who laid the foundation of the present methods of organised and systematic meteorological work in India.

On Mr. Blanford's retirement in May 1889 Sir John (then Mr.) Eliot was appointed permanently to his post, and the duties of the office were enlarged in April 1899 when the Meteorological Reporter was given charge of the astronomical and magnetic observatories of Madras and Bombay with the additional title of Director-General of Indian Observatories.

The activity and efficiency of the Department were greatly increased under Sir John Eliot's administration. The India Daily Weather Report has been extended, improved and illustrated with charts, local Provincial Reports at Bombay and Madras have been established, the work of storm and flood warning has been extended, and rainfall registration has been systematised. Arrangements have also been made for collecting marine observations from ships' logs at Calcutta and Bombay, and from observatories over the Indian Ocean.

On the more purely scientific side a new observatory for work in modern physical astronomy, especially in relation to the sun, has been instituted at Kodaikanal in the Palni Hills: the experimental work at the observatories of Alipore (Calcutta) and Colaba (Bombay) has increased, and several new magnetic observatories have been erected.

Sir John Eliot has published numerous memoirs and has added enormously to our knowledge of Indian meteorology: among other matters on which he has thrown much light are the development of tropical cyclones, the origin and characteristics of cold weather storms and the effects of vertical pressure-gradients. He has also created our present methods of seasonal forecasting.

In a resolution, dated 2nd January 1904, based on the Administration Report of the department for 1902-03 the Government of India expressed their

Wall. D

appreciation of the services of the retiring Meteorological Reporter: and of this resolution the last sentence may be quoted:—

> "In the whole of the time during which he has administered the Department Sir J. Eliot has laboured steadily and successfully, and with the most careful regard to economy, to increase its efficiency, and he now retires having earned the sincere thanks of the Government of India for his long and meritorious services."

Happily arrangements have been made for securing further work from Sir John Eliot: he is now engaged on a climatological atlas of India, a hardbook of Indian meteorology and additional meteorological investigations.

It had been determined to seek in England as the new head a man possessed of the necessary qualifications, and acting on the advice of the Observatories Committee of the Royal Society Mr. Gilbert T. Walker, a Cambridge lecturer on mathematical physics, was appointed. He underwent a preliminary training in England, the United States, France and Germany, and acted for six months as Special Assistant to the Meteorological Reporter before taking over charge of the Department on 1st January 1904.

Appointment of Mr. C. W. Peake as Acting Second Assistant to the Meteorological Reporter to the Government of India.

2. Leave without pay for eight months from 31st March 1903 was granted by Government to Mr. G. W. Küchler, Second Assistant to the India Meteorological Reporter, and Mr. C. W. Peake, M. A., Professor at the Civil Engineering College, Sibpur, was appointed to act for him. Mr. Küchler returned on 18th December 1903.

Amalgamation of the two meteorological appointments at Calcutta.

3. Sanction was given on 15th January 1904 by the Secretary of State for the amalgamation of the offices of Meteorological Reporter to the Government of Bengal and of Second Assistant Meteorological Reporter to the Government of India: this return to a former condition will effect considerable economy and was actually carried out on 15th March 1904, when Mr. Little went on furlough. Arrangements are being made in consequence for the transfer of the Bengal meteorological office to the buildings of the former magnetic observatory in the compound of the India meteorological office, Alipore.

Mr. Little had been appointed Second Assistant to the India Meteorological Reporter in May 1889 and was deputed to act as Bengal Meteorological Reporter three months later. In April 1896 when the Bengal and India offices were separated and housed in different parts of the same building, Mr. Little received the substantive appointment of Bengal Reporter in which capacity he had acted for five periods, and in May 1896 Mr. Küchler was appointed to officiate as Second Assistant to the India Reporter: he was given this post substantively in August 1898. During Mr. Little's fifteen years in this Department the number of stations under his charge had materially increased and considerable improvements were effected in the Daily Weather Reports issued by the Bengal Meteorological office.

OBSERVATORIES.

4. The observatories maintained by the Government of India are classified as follows:—

First class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, rainfall and wind direction and velocity.

Second class.—Observatories at which observations are taken daily at 8 hours, 10 hours and 16 hours: those at 8 hours are (with a few exceptions) transmitted by weather telegram to Simla, Calcutta, Bombay or Madras for inclusion in the India or Provincial Daily Weather Reports.

Third class.—Observatories—

(*a*) at stations where there are telegraph offices, and at which observations are taken daily at 8 hours only, and trans-

mitted by weather telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports;

(*b*) at stations where there are no telegraph offices, and which record observations at 10 hours and 16 hours only, in some cases for inclusion in the Monthly Weather Reviews, and in others to furnish a series of observations for the determination of monthly and daily means for these stations, which shall be comparable with the means already obtained for second class observatories. At a few such stations, chiefly Extra Indian, observations are recorded at 8 hours only.

Fourth class.—Observatories at which observations of temperature, wind direction and rainfall only are recorded.

5. At the commencement of the year 240 observatories contributed registers of meteorological data; of these 50 were non-departmental and 190 maintained by the Government of India. At the end of the year the total number of observatories was 242, of which 49 were non-departmenal and 193 maintainted by the Government of India.

Of the 193 departmental observatories, 7 were first class, 41 were second class and 145 third class.

6. The only change in non-departmental observatories during the year was the following:—

(1) The third class observatory at Maymyo was converted to a departmental observatory on the 1st January 1904.

7. The following gives the changes in departmental observatories during the year under review:—

(1) Kalabagh and Sarain, the two second class observatories on the Chôr Peak, were opened on the 4th July 1903.

(2) Third class observatories were opened at Pendra Road, Laheria Sarai and Myitkyina on the 23rd June 1903, the 27th July 1903 and the 5th October 1903, respectively.

(3) The third class observatories of Taunggyi, Secunderabad and Mussooree were closed on the 12th June 1903, the 1st January 1904 and the 1st March 1904, respectively.

8. The observatory at Dodabetta is furnished with continuous self-registering barograph, thermograph and Beckley's anemograph in addition to the usual instruments for eye observations: it is now in full working order. The observatory was inspected by Mr. Jones and certain improvements made. The anemograph went out of order, and the damaged parts were repaired in July 1903; arrangements have been made according to which the observer attends daily from 10 A.M. to 4 P.M. and records a short series of eye observations for comparison with the traces of the barograph and thermograph.

9. The observatories at Sarain and Kalabagh on the Chôr Peak, sanctioned in 1899, were completed and made over to the department in June 1903: land for the buildings was obtained from the Jubbal State. The observatories were started in July 1903 but ceased at Kalabagh from the middle of December until the middle of April owing to the accumulation of snow which made the path up the mountain impassable. Both stations are now provided with daily barographs and thermographs, but self-recording instruments capable of continuous registration for several months at the upper station have not yet been obtained.

10. The Beckley's anemograph which had been in use at the Nagpur Observatory for the last 22 years had afforded sufficient data for meteorological study. It has therefore been withdrawn.

11. The Dines' Pressure-tube anemometer at Ratnagiri was found to be damaged by the sea-air and had to be withdrawn.

12. Meteorological instruments have been provided for certain officers attached to the Thibet Mission and to the Aden Column.

First Class Observatories.

13. The Directors of the Government Observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded through the Department for the information of Government. It has hence been ruled that under present arrangements it is unnecessary to include information relating to the working of these observatories in the Administration Report of the Meteorological Department.

14. *The Alipore Observatory.*—This observatory is under the charge of the Second Assistant Meteorological Reporter to the Government of India. It is furnished with a complete set of autographic instruments, including a Whipple-Casella sunshine recorder, a Callendar sunshine recorder, a Bergholz barograph, a Kew barograph and a Kew thermograph, a Beckley's anemograph, a Dines' pressure-tube anemometer, a Beckley's rain-gauge and also a Milne's horizontal pendulum seismograph.

15. The self-registering instruments worked satisfactorily during the past year. The measurements from the traces of the Kew barograph and thermograph have been compared with the eye-readings of the standard barometer, and the dry and wet bulbs in the same manner as in the previous fourteen years. The following gives the mean differences for the years 1902 and 1903 and also for the past thirteen years :—

	Period 1889-98.	Period 1899-1903.*	1902.	1903.
Mean difference between the standard barometer and barograph during the period or year (*i.e.*, standard barometer *minus* barograph).	" +·022	" +·025	" +·025	" +·028
Mean difference between the dry bulb in the thermometer shed and the dry bulb trace of the thermograph (*i.e.*, thermograph *minus* shed dry bulb thermometer).	° +0·61	° —0·10	° —0·18	° —0·03
Mean difference between the wet bulb in the thermometer shed and the wet bulb trace of the theromograph (*i.e.*, thermograph *minus* wet bulb therometer)	° +0·74	° +0·88	° +1·00	° +1·18

* Exposure was slightly changed during this period by removing certain trees which impeded the free circulation of the air round the thermometers.

16. All instruments issued by the Meteorological Department are carefully tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 400 as compared with 339 last year. Sixty-one instruments were condemned as unfit for issue or were sent for repair to the Mathematical Instrument Department.

17. The observatory gives mean Calcutta time to the port and shipping. Three time balls were dropped daily at 1 P.M. local mean time during the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore docks.

This work was, on the whole, carried out satisfactorily during the year. There were twenty failures as compared with the average number 10·5 of the past fifteen years.—

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1903-1904	20	20
1902-1903	14	14
1901-1902	13	13
1900-1901	15	15
1899-1900	13	13
1898-1899	6	6
Mean of ten years 1888-98	10	10

18. *The Allahabad Observatory.*—This observatory is under the charge of the Meteorological Reporter to the Government of the United Provinces of Agra and Oudh. Observations are taken of considerable number of instruments in addition to those of the ordinary meteorological instruments supplied to all observatories. The following is a statement of these instruments and of the records obtained from them :—

The Beckley's anemograph was overhauled in November 1903, but has not given very satisfactory wind records. The sunshine recorder worked well throughout the year, and the Draper's thermograph fairly well. The records are all tabulated to date.

The float of the Dines' pressure-tube anemometer was found to be too heavy: on this defect being remedied the instrument worked better than ever before. A second instrument of the same type has been installed and will be used for purposes of comparison.

Regular observations of the nature and movements of clouds were made throughout the year with the aid of a Duboscq's nephoscope.

A continuous record of the barometric pressure throughout the year was obtained by a Richard Frères open scale barograph. The records (which have all been tabulated) are satisfactory.

A Richard Frères thermograph was in use throughout the year. It gave excellent results as a dry bulb instrument. Its wet bulb record was not very satisfactory in the hot weather.

A battery of five solar radiation thermometers to measure the intensity of the sun's heat and a grass thermometer to measure terrestrial radiation were in use during the year.

Ground temperatures at the surface, and at depths of one and three feet were recorded at 6h., 14h. and 22h. The temperature at the depth of 9 feet was observed at 14h.

19. *The Lahore Observatory.*—No change was made in the work of this observatory. Eye observations of all instruments are recorded seven times per diem and automatic records of pressure, temperature, sunshine, wind and rain are obtained from self-registering instruments. Two new underground thermometers have been supplied and temperatures have thus been recorded on the surface, and at depths of 1 foot, 3 feet, 6 feet, 12½ feet and 25 feet.

Character of the work of observation at Second and Third Class Observatories.

20. In general the character of the work of the observatories was somewhat less satisfactory during the year under review than during the year 1902-03.

21. A good test of the carefulness and accuracy of the observers is the correctness of the weather telegrams they forward to Simla. The work done at 142 of the 166 meteorological observatories reporting daily by telegraph to Simla (86 per cent. of the whole) was entirely satisfactory and the observations trustworthy and accurate throughout the year. At the following nine departmental observatories the work was very unsatisfactory, *viz.*, Bahraich, Bassein Chaman, Hyderabad (Sind), Mainpuri, Malegaon, Mandalay, Muscat, and Thayetmyo. The number of erroneous observations detected during the year at Thayetmyo was 252, at Bahraich 93, at Malegaon 79, at Bassein 77, at Mandalay 68, and at Sonemarg (non-departmental) 74. There has been a slight improvement in the observational work in Burma. Both Bassein and Mandalay have made fewer mistakes in 1903-04 than in 1902-03, but, on the other hand, Thayetmyo has deteriorated considerably and there is still need for improvement at the observatories in Burma. In the United Provinces both Bahraich and Mainpuri recorded erroneous observations much too frequently, and at Malegaon in Bombay the observational work was equally unsatisfactory. At these three stations the unsatisfactory work was, at least in part, due to changes in the observers and to incompleteness of training.

The usual list showing the number of observations rejected, and also the number of telegrams incorrectly prepared, for all the observatories which send weather telegrams to the Simla, Calcutta, Bombay and Madras offices, was prepared and circulated to the observatories at the end of the year under review.

Inspection of Observatories.

22. An average amount of inspection was done during the past year. Sixty-nine observatories in all were inspected as compared with an average of 72 during the past six years. The Imperial Reporter inspected 15 stations (including the important first class observatories at Alipore, Colaba, Madras and Kodaikanal). Six observatories were inspected by Mr. Hill, Meteorological Reporter to the Government of the United Provinces. Twenty-two observatories were inspected by Mr. Gaetane, Inspector of Observatories, six by the Head Clerk of the Bengal Meteorological office, fourteen by the Head Clerk of the Bombay Meteorological office, two by the Chief Observer of the Lahore Observatory, two by the Head Clerk of the Madras Meteorological office, one by the Meteorological Reporter to the Government of Madras and one by the Second Assistant, Simla Meteorological office.

23. The following gives a comparative statement of the condition of the observatories inspected during the year and during each of the previous six years :—

Condition.	Number of observatories inspected in						
	1903-04.	1902-03.	1901-02.	1900-01.	1899-1900.	1898-99.	1897-98.
Very satisfactory . .	9	9	7	10	6	5	6
Satisfactory . . .	36	46	54	43	27	33	20
Fair	22	21	12	33	19	19	13
Bad	2	10	9	13	5	5	5
Total .	69	86	82	99	57	62	44

The visits to Laheria Sarai and Pendra were for the purpose of starting the observatories, that to Cherat to set up the anemograph which had been removed from Simla to Cherat and that to Dodabetta to take up and place in position a new barometer. A large proportion of the remaining sixty-five visits were made in order to determine whether persistent errors in the observations telegraphed were due to instrumental changes or to careless observation. In the majority of cases the errors were found to be due to changes in the index errors of the instruments, but at the following stations, *viz.*, Mandalay, Bassein, Jessore, Bahraich, Mainpuri, Meerut, Bareilly, Muscat and Hyderabad (Sind) they were found to be due to careless and inaccurate observations or to changes in the surroundings of the observatories.

24. The work of inspection is not yet so fully carried out as I should like to see it. Frequent inspection of observatories, more specially these located at hospitals, dispensaries and post offices, is absolutely essential, on account of the occasional changes of observers at short intervals necessitated by acting and other arrangements in the Medical and Postal Departments. The Postal Department has issued a circular directing that in all cases where it is feasible time should be given to train the new observer before the old observer leaves the station: but occasionally a half-time observer belonging to one of these departments is transferred at 24 hours notice and the successor is compelled to take up the meteorological work without any training from his predecessor; and it is frequently impossible in such cases to make arrangements to inspect the observatory and train the observer till several weeks have passed.

Storm Observations.

25. A larger number of special observations of storms were sent in during the year 1903-1904 than during the previous year, while the same strictness in the assignment of rewards was observed. These rewards are now only granted for observations of real value for the investigation of the phenomena and distribution of the various classes of storms which affect weather in India. The great majority of the reports submitted were observations of the various classes of storms of the hot weather, *i.e.*, thunderstorms, hailstorms and duststorms. About five hundred and eighteen sets of storm observations in all were sent in by 80 observers during the year. In addition, a large number of special observations of various kinds were taken by certain observers for the information and use of the department, chiefly in connection with the work of storm and flood warning. For these storm and special observations amounts varying from four annas to one hundred rupees were awarded.

Observations of special Meteorological instruments.

26. The following special observations were carried out during the past year at certain selected stations:—

1st.—Wind observations recorded by Beckley's anemographs at nineteen stations and by Dines' pressure-tube anemometers at twelve stations.
2nd.—Solar and terrestrial radiation observations at ten stations.
3rd.—Underground temperature observations at six stations.
4th.—Sunshine observations at nine stations.
5th.—Barometric observations recorded by self-registering instruments, chiefly Richard Frères barographs, at thirty-eight stations.
6th.—Thermometric observations recorded by self-registering instruments, chiefly Richard Frères thermographs, at thirty-six stations.

27. There were no large changes in this class of work during the year under review.

The new station at which a Beckley's anemograph was installed was Cherat. The underground temperature observations at Lahore were rearranged and two new thermometers recording at $12\frac{1}{2}$ and 25 feet were added. A Richard Frères barograph was supplied to Kalabagh (Chôr Peak) and Richard Frères thermographs to Sarain and Muktesar.

Seismograph Observations.

28. Seismological observations were recorded for the Seismological Committee appointed by the British Association by means of Milne's self-registering seismograph during the year, as in previous years, at Alipore (Calcutta), Colaba (Bombay) and Kodaikanal. All the instruments worked satisfactorily throughout the year, and their records were regularly transmitted to the Seismological Committee of the British Association. Apparatus has also been introduced at Colaba to measure the vertical movement of the ground and its actual tilt. The working of the seismograph at Alipore was, in the year under review, quite satisfactory and its records of the chief disturbances were in accord with those of Colaba and Kodaikanal.

Marine Meteorology.

29. This work was carried out during the year under review in the same way as during the past nine years. One clerk of the Calcutta office was engaged during the year in collecting meteorological data from ships entering the Hooghly. He also made a careful comparison by means of secondary standards of the barometers on board the ships from which data were obtained, in order to ascertain the corrections to be applied to the barometric readings extracted from the logs of the vessels. The Bombay Meteorological office collected data from vessels entering the port of Bombay by the same methods as are employed at Calcutta. The data collected on each day are usually sent off by post to Simla on the following day, any portions that are required for the use of the Calcutta and Bombay offices being copied out without delay. Three logs were received during the year from the Port Officer, Rangoon.

39. The following table gives a statement of the work done under this head during the year, and the corresponding figures of the seven previous years, for comparison :—

		1903-04.	1902-1903.	1901-1902.	1900-1901.	1899-1900.	1898-99.	1897-98.	1896-97.
CALCUTTA	Number of logs extracted.	1,299	1,164	1,168	1,322	1,302	1,284	1,325	1,140
	Number of barometric comparisons.	4,398	4,074	4,104	4,104	4,086	4,002	4,218	4,508
BOMBAY	Number of logs extracted.	942	877	883 [c]	991 [c]	975	1,015	972	1,017
	Number of barometric comparisons.	3,665	3,938	4,127	5,470	3,900	5,904	5,881	6,197

There was thus some increase in the number of logs extracted and of barometric comparisons made both at Calcutta and Bombay as compared with the previous twelve months.

31. The issue of Pilot charts giving, month by month, the normal meteorological conditions over the Indian seas and the Indian Ocean as far south as Lat. 12° S., was continued. These charts show the mean pressure, the mean direction and force of the wind, the mean surface currents and the ordinary tracks of storms in the month under review, together with a brief synopsis of the normal conditions of the month.

The chart for each month was issued about the 20th of the month preceding the period to which it referred. A small charge of four annas was made for each copy. The total monthly issue amounts to about 160 copies.

A proposal is now under consideration to alter the method of publication of these charts and instead of issuing them month by month, year after year, to issue a small atlas containing the twelve monthly charts of normal conditions and such additional charts of special conditions as it may be thought desirable to include in order to make the atlas as useful as possible.

Observations recorded during the year on board the Light Vessels at the entrance to the River Hooghly were supplied to the Meteorological Department.

The F. L. V. *Torch* on the Ridge station furnished observations from April 1st, 1903 to March 31st, 1904.

The F. L. V. *Planet* and *Star* at the Intermediate station sent in observations for seven months of the year.

SNOWFALL REGISTRATION IN THE MOUNTAIN DISTRICTS OF NORTHERN INDIA.

32. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas for the cold weather of 1903-04, was on the whole fairly complete and the thanks of the Department are due to the various officers who have collected and forwarded snowfall information during the past winter.

RAINFALL REGISTRATION.

33. No change was made in the system or methods of rainfall registration during the year under review. A full account of the methods employed, which came into full operation during the year 1891-92, will be found in pages 5—8 of the Administration Report of the year 1889-90, and pages 6—7 of the Administration Report of the year 1890-91.

34. The following gives a classified statement of the total number of rain-gauge stations at the end of the year in the various political divisions of

the empire and of the number of rain-gauge stations of which inspection reports were received by the India Meteorological office during the year 1903-04.

Province or Division.	Number of rain-gauges on 31st March 1904.	Number of inspections of rain-gauges reported in 1903-04 (the duplicate copies of which received by the Simla Meteorological Office).				Percentage of inspections to total number of rain-gauges, as reported by the Revenue Officers.
		Good.	Fair.	Bad.	Total.	
Assam	117	52	13	1	66	71
Baluchistan	54	...	...	...	...	...
Bengal	380	55	17	4	76	100
Bombay and Sind . . .	334	...	...	...	...	91
Burma	175	37	3	...	40	75
Central India . . .	65	...	...	...	...	...
Central Provinces . .	135	153	33	...	186	133
Hyderabad	22	...	...	...	...	...
Kashmir . . .	36	...	...	...	...	...
Madras (including Pudukota, Coorg, Travancore and Cochin).	462	283	93	12	388	75
Mysore	77	...	...	...	...	...
North-West Frontier Province .	31	1	1	...	2	...
Punjab	189	73	12	...	85	58
Rajputana	157	19	...	...	19	...
United Provinces of Agra and Oudh.	289	26	11	...	37	57
Total .	2,523	699	183	17	899	...

Note.—In several cases the same gauge was inspected more than once during the year.

35. The registration of rainfall in India has invariably been carried out by the Provincial authorities and in the larger provinces under the general control of the Boards of Revenue. Previous to 1889 the hours and arrangements for the registration of rainfall differed largely in different provinces. In 1889 a uniform system was introduced by the Government of India, and the Meteorological Reporter to the Government of India was made consulting officer in connection with this work. The local officers superintending the registration of rainfall submit brief annual administrative reports to their respective Governments, copies of which are forwarded to the Imperial Meteorological Reporter.

36. The following paragraphs give a brief summary of the reports on rainfall registration for the year 1903-04 submitted to the various Local Governments and Administrations by these local officers :—

37. *Assam* :—The number of stations on the 31st March 1904 was 117 (55 under Government and 62 under private management). One new station was opened and three were given up during the year.

On the whole the work of inspection was well done, only 31 stations remaining unvisited as was the case in the previous year.

In Nowgong and the Khasi and Jaintia Hills more than half the number of stations escaped inspection while in Lakhimpur only two out of twelve stations were inspected.

38. *Baluchistan* :—No report received

39. *Bengal*:—The number of rain-gauge stations on the 31st March 1904 was 380, *i. e.*, 6 more than on the corresponding date last year. Six stations were started and none were closed during the year.

The number of visits of inspection made during the year was 379, against 415 during 1902-1903. The total number of rain-gauges inspected was 230, against 232 in the previous year. The reports received from the inspecting

officers showed that the rain-gauges were for the most part in good condition and the rainfall registers properly kept. The rain-gauges in Orissa and Chota Nagpur Tributary Mahals were visited for the first time during the past year.

40. *Bombay :*—The total number of rain-gauges in the Presidency including Sind was 334. Three new stations were opened during the year under report. Of the 274 gauges in British districts 191 or nearly 70 per cent. came under inspection, but inspections in the Native States show a decrease, only 23 out of the 60 gauges having been inspected. Inspection was inadequate in the Deccan and Sind districts and in Kolhapur, Mahi Kantha and Kathiawar.

41. *Burma.*—Twenty-four registering stations were opened during the year, making 176 as the total number of stations recording rainfall at the close of the year.

The twenty-four new gauges have not yet been inspected but of the remainder, 152 in number, 131 were inspected. Of these 113 were found in good condition, and four were bad mainly owing to faulty position.

42. *Central India :*—No report received.

43. *Central Provinces :*—The number of rain-registering stations is 123, in addition to 12 observatories of the Meteorological Department : four new stations were established while no station was abolished during the year. The number of inspections of rain-gauge stations during the year was 179. All defects reported received attention and the results obtained during the year are reported as satisfactory.

The district of Berar has now been incorporated with the Central Provinces and the above figures represent the combined figures of the whole area.

44. *Hyderabad :*—No report received.

45. *Kashmir :*—No report received.

46. *Madras :*—On the 31st March 1904, there were 435 rain-recording stations, excluding 27 meteorological observatories, furnishing rainfall returns for publication in the *Fort St. George Gazette.* Of these 3 were added during the year under report. Of this total, 374 are in the Madras Presidency and of these 338 were inspected during the year or 90 per cent. of the total number. There was improvement in the amount of inspection in the Vizagapatam, Godaveri, Kistna, South Arcot, Tanjore, Trichinopoly, Tinnevelly and Nilgiri districts as compared with last year, while in Ganjam, Chingleput, South Canara, Salem, Anantapur, Bellary and Kurnool the amount was slightly less. In the Nilgiris 5 out of 9 stations were inspected.

All the defects in the Inspection Reports sent in during the year have been or are being rectified. In January 1904 a list of rain-gauges in each district not inspected or reported on since 1st April 1903 was sent to the Collector of that district, with a request that, if possible, these gauges should be inspected before the end of the official year.

47. *Mysore :*—No report received.

48. *North-West Frontier Province :*—No report received.

49. *Punjab :*—There was no change in the number of rain-registering stations during the year, which, as last year, stands at 189.

The total number of inspections made by Revenue Officers in the Punjab and reported to this office was 110, as against 76 reported in the previous year. No reports of any inspections made during the year have been received from the Commissioners of Rawalpindi and Mooltan Divisions, or the Deputy Commissioners of Simla, Hoshiarpur, Lahore, and Mianwali districts. It is probable that these officers may have made some inspections but have omitted to report the fact.

The reports received from the officers of the Canal Department show that the rain-gauges under their charge have been regularly inspected from time to time during the year by Executive and Assistant Engineers and that the gauges have been maintained in good order.

The rain-gauges in the Punjab are, in the opinion of the Director of Land Records, in good order, and the rainfall records properly kept.

50. *Rajputana :*—No report received.

51. *United Provinces of Agra and Oudh :*—There are 289 rain-reporting stations in these Provinces, including the meteorological observatories and two duplicate stations in the Meerut District.

Regular and complete reports of inspections were received from eleven districts. The work of inspection was only partially carried out in the remaining 37 districts.

No reports of inspections were received during the year from four districts; and in three districts only one station in each was inspected.

One hundred and sixty-four stations, or 59 per cent. of the whole, were reported as inspected during the year, 30 of them having been inspected more than once. This is practically the same number as last year.

52. ***Summary.***—The work of rainfall registration is steadily improving and is now satisfactorily carried out over nearly the whole empire.

The work of inspection was best done in the Central Provinces, Assam and Madras and has improved considerably in the Punjab and Burma. No material increase of inspection was made in the United Provinces of Agra and Oudh. The steady improvement in this important branch of meteorological work is very creditable to the officers in charge of the rainfall registration.

Seasonal Forecasts.

53. The forecast of the probable character of the rainfall during the south-west monsoon of 1903 was issued confidentially in the same form as in the preceding twelve years under the heading of "Memorandum on the snowfall in the mountain districts bordering Northern India, and the abnormal features of the weather in Indian monsoon area during the past year with a statement regarding the probable character of the south-west monsoon rains of 1903."

54. The following gives the statement of the forecast as published in this memorandum:—

(1) That the monsoon currents will on the average of the whole period be of at least normal strength and probably somewhat above it.

(2) That there will be some delay in the establishment of the current on the West Coast. It is probable that they will commence about the 15th June on the Bombay Coast and about the normal date, viz., the third week of June, on the Bengal Coast.

(3) That the West Coast current will appear more nearly simultaneously than usual at all parts of the Coast. There is a slight probability that there will be no considerable delay in the advance of the monsoon currents across the head of the Peninsula and up the Gangetic Plain after the establishment of the corresponding currents in the coast districts.

(4) That the Bombay current may be somewhat weaker and less steady than usual for two or three weeks after its establishment.

(5) That the Bay current is somewhat more likely to give excess rain than the Arabian Sea current, but that both are likely to be less steady than usual during June.

(6) That the average rainfall of the whole of India for the whole monsoon period will be normal or in slight excess.

55. The following inferences were also deduced respecting the distribution of the south-west monsoon rains:—

(1) Conditions are normal in Burma and the rainfall of the period will probably be at least normal in Lower and Central Burma, and normal or in slight defect in Upper Burma.

(2) Conditions in Assam are similar to but slightly less favourable than those obtaining in Burma, and the rainfall in that area will most probably be normal, but may, as in Upper Burma, be in slight defect.

(3) The general and local conditions are favourable in Bengal and the rainfall of the period on the average of the whole area will very probably be at least normal, and probably in slight to moderate excess except in the western districts (including Chota Nagpur). The conditions in Orissa are less favourable than in Bengal, and the rainfall in that area will probably not be above the normal.

(4) Conditions are favourable in Bihar and the United Provinces and those provinces will very probably receive at least their normal amount of rain. The probability of increased rainfall is greater for the eastern than the western districts.

(5) Conditions were somewhat unfavourable in the Punjab, Sind and West Rajputana during the greater part of May, but improved rapidly during the last week of the month. It is hence probable if the monsoon be of at least normal strength that the East and North Punjab will receive about normal

rainfall, but that there may be deficiency in the western districts of comparatively light rain.

(6) The eastern and central districts of Rajputana will also probably obtain about their normal amount of rain and the western districts less than the normal.

(7) Conditions are not so favourable in Central India as in the United Provinces, and that area will hence probably receive its normal amount of rain.

(8) Conditions, more especially the pressure conditions, appear to indicate that the Central Provinces will not receive more than their normal amount, and that the rainfall is more likely to be in defect in the eastern than the western districts.

(9) In Hyderabad Deccan conditions are more favourable than in the Central Provinces, and that area will hence probably obtain about its normal amount.

(10) Conditions are practically normal in Berar and Khandesh, and the rainfall in these areas will probably be at least normal. They are also favourable in the West Deccan, and that area will probably at least receive its normal fall.

(11) The general and local conditions in the west coast districts are such as are usually associated with approximately normal rainfall. It is very probable that the rainfall of the present year will be either normal or in slight defect in the Konkan depending upon the strength of the monsoon. The conditions are slightly less favourable in Gujarat but, so far as can be judged, that area will obtain about its normal fall.

(12) The variations of the rainfall in the North Madras coast districts are in about five years out of six, similar to those of the Central Provinces and Orissa, in which the conditions are somewhat unfavourable. It is probable that the rainfall will be slightly below the normal in those districts.

(13) Conditions appear to be favourable for at least normal rain during the period June to September in the Madras Deccan, Mysore and Carnatic (assuming that the monsoon will during the greater part of the period be stronger than usual).

56. The following table gives rainfall data of the south-west monsoon of 1903 for fourteen political divisions for comparison with the forecast :—

Province or Division.	Rainfall of season, June to October.			
	Average actual, 1903.	Average normal.	Departure from normal.	Percentage departure from normal.
	Inches.	Inches.	Inches.	
Burma	98·28	97·90	+0·38	0
Assam	84·04	75·51	+8·53	+11
Bengal	60·61	62·22	—1·61	— 3
Chota Nagpur	42·28	48·40	—6·12	—13
Bihar	35·32	44·60	—9·28	—21
United Provinces of Agra and Oudh	41·30	36·03	+5·27	+15
Punjab	13·88	14·29	—0·41	— 3
Baluchistan	1·39	2·16	—0·77	—36
Central Provinces . . .	47·73	46·00	+1·73	+ 4
Central India	37·65	36·31	+1·34	+ 4
Rajputana	18·33	16·84	+1·49	+ 9
Berar	35·37	29·61	+5·76	+19
Bombay	38·92	40·53	—1·61	— 4
Madras	38·57	34·10	+4·47	+13

57. The forecast of the general character proved to be very fairly correct. The chief abnormalities in the local distribution were the large rainfalls in Berar and Madras, the early deficiency and late excess in the United Provinces, and the deficiency in Chota Nagpur and Bihar. The only case of complete error in the prediction was that of Bihar.

58. The forecast of the rainfall in August and September was issued confidentially in the usual form. The conclusion was that it was probable :—

(*a*) That the Bombay current will be of about normal strength during the month of August and the first-half of September.

(*b*) That the Bay current will increase in the first fortnight of August and be of at least moderate strength and may be of normal strength, in the second-half of August and in September.

(*c*) That the field of the Bombay current will continue to receive favourable to abundant rain.

(*d*) That the rains will not terminate in Upper India before the middle of September.

(*e*) That the Bay current will increase in strength during the first-half of August, and hence that Northern India will receive moderate to normal rain during the second-half of the monsoon period.

(*f*) That the area in the Gangetic Plain where the rainfall has been scanty will receive at least moderate rain, and may receive early and satisfactory rain, if, as is anticipated, the Bay current increases to at least normal strength in August.

59. The vigour of the monsoon was somewhat overestimated, but the improvement in the United Provinces was correctly predicted and the forecast was on the whole successful.

60. The following was the forecast of the cold weather precipitation from December 1903 to February 1904, as issued confidentially in the usual form :—

(1) The winter precipitation in Persia and Baluchistan will very probably be below the normal probably to a moderate extent.

(2) The snowfall in the Punjab Himalayas and the Afghan Mountains will probably be below the normal, though the defect is not likely to be large.

(3) The winter rains (due to cold-weather storms originating in the Persian area) in the Punjab, Sind and Rajputana from December to February are not likely to be above normal and will probably be in moderate defect.

(4) It is probable that the winter precipitation in the Gangetic Plain due to the same causes will be below the normal.

(5) There are, so far as can be judged from the data, no special features of importance in the meteorological conditions of Central India and the Central Provinces. It is hence improbable that these areas will receive more than normal rainfall.

(6) There are indications of delay in the commencement of the winter rains, and it is very probable that they will not begin before the fourth week of December.

61. The following statement gives comparative rainfall data of the larger provinces of Northern and Central India for the period December 1903 to February 1904 :—

Province or Division.	Rainfall of period, December to February.			
	Average actual, 1903-04.	Average normal.	Departure from normal.	Percentage departure from normal.
	Inches.	Inches.	Inches.	
Burma	0·32	0·51	—0·19	— 37
Assam	3·16	2·65	+0·51	+ 19
Bengal	1·12	1·42	—0·30	— 21
Chota Nagpur	0·76	1·55	—0·79	— 51
Bihar	0·40	1·40	—1·00	— 71
United Provinces of Agra and Oudh.	0·44	1 70	—1·26	— 74
Punjab	1·93	2·52	—0·54	21
Baluchistan	3·31	3·89	—0·58	— 15
Central Provinces . . .	0·71	1·17	—0·46	— 39
Central India	0·61	1·27	—0·66	— 52
Rajputana	0·27	0·75	—0·48	— 64
Berar	0·29	0·80	—0·51	— 64
Bombay	0·44	0·36	+0·08	+ 22
Madras	5·69	2·55	+3·14	+123

62. It will be seen that the forecast of Indian rainfall was successful: the time of commencement was also rightly indicated. The snowfall of Afghanistan, Baluchistan and the Punjab Hills was in very slight defect, but that of Persia appears to have been in slight excess.

Storm Warnings.

63. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed by two officers. Ports on the Bay of Bengal are warned from the Calcutta Office by the Meteorological Reporter to the Government of Bengal, and ports on the Arabian Sea Coast from the Simla Office by the Meteorological Reporter or Assistant Meteorological Reporter to the Government of India.

The present system of storm signals was brought into operation on the 1st April 1898.

The complete system at present in operation includes:—

1st.—An extended system of storm signals for use at the larger and more important ports.

2nd.—A brief system of storm signals for use at the smaller ports, chiefly for information of native or country vessels.

64. ***Bay of Bengal Storm Signal Service.***—The following gives a list of the ports which were warned during the year 1903-4 by the Meteorological Reporter to the Government of Bengal:—

(*a*) *Burma Ports*—	(*b*) *Bengal Ports*—	(*c*) *Madras Ports*—
Mergui.	Calcutta and River Hooghly.	Gopalpur.
Tavoy.	Narayanganj.	Bimlipatam.
Moulmein.	Chittagong.	Vizagapatam.
Rangoon.	Orissa Ports, including Puri,	Cocanada.
Bassein.	False Point, Chandbali and	Masulipatam.
Akyab.	Balasore.	Madras.
		Negapatam.
		Pamban.
		Tuticorin.

The following gives the arrangement of the ports according to the method of warning adopted:—

Bay of Bengal Ports.

I.—By extended system.		*II.—By brief system.*	
Tavoy.	Calcutta and River Hooghly.	Cocanada.	Narayanganj.
Moulmein.	False Point.	Masulipatam.	Balasore.
Rangoon.	Puri.	Madras.	Chandbali.
Bassein.	Gopalpur.	Negapatam.	
Akyab.	Bimlipatam.	Pamban.	
Chittagong.	Vizagapatam.	Tuticorin.	

Telegraphic information is also sent to Chittagong, Narayanganj and the Orissa ports whenever storm signals are hoisted at Saugor Island. This extension was suggested by the Government of Bengal in May 1898.

It may be noted that in the case of the Bengal ports, the signals are hoisted by the direct orders of the Meteorological Reporter to the Government of Bengal. In the cases of the Burma and Coromandel Coast ports, the storm signals are hoisted by the orders of the port officers, acting on information respecting the path and intensity of the storms received at short intervals during their progress from the Meteorological Reporter to the Government of Bengal.

Storm signals were hoisted for thirteen storms which affected ports in the Bay of Bengal: this number is in excess of the average but the storms were as a rule of feeble intensity. May and June were very quiet months, but weather was more unsettled than usual in November and December. No storm developed into a cyclone.

There are also certain special arrangements at Calcutta for supplying the latest weather information by means of flag-signal hoist messages to certain ports of the Bay for the information of outward-bound shipping when passing Saugor Island, and for obtaining early information of the weather at the head of the Bay from vessels entering the Hooghly. These arrangements worked

satisfactorily throughout the year, and occasionally gave information of much value to the mail and coasting steamers of the British India and other shipping companies.

65. ***Bombay Storm Signal Service.***—The work of warning the Bombay ports was carried out during the past year by the Simla Meteorological Office under the arrangements introduced in September 1889, and fully stated in pages 17 and 18 of the Administration Report of 1889-90. The Simla Office also warned the Madras ports on the Malabar coast in the same manner as the Bengal Reporter warned the Madras ports on the coast of the Bay of Bengal. Warnings of storms in the Arabian Sea were also sent to the Port Officer, Aden, for the information of steamers leaving that port for Colombo, Bombay and Kurrachee. Copies of all warnings sent to the Malabar ports were forwarded for information to the Master Attendant, Colombo, the Commercial Agent to the Diwan of Alleppy, the Presidency Port Officer, Madras, the Deputy Port Conservator, Madras, and the Chief Engineer for Irrigation, Madras.

The following is a list of the Bombay and Malabar ports warned under this system during the year 1903-04 by the Simla Meteorological Office:—

(*a*) *Bombay Ports.*			(*b*) *Malabar Ports.*
Kurrachee.	Daman.	Mormugao.	Mangalore.
Cutch-Mandvi.	Bombay.	Goa.	Tellicherry.
Jamnagar.	Alibag.	Vengurla.	Calicut.
Dwarka.	Murud-Janjira.	Karwar.	Cochin.
Porbandar.	Ratnagiri.	Kumta.	
Veraval.	Malwan.	Honavar.	
Jafrabad.			
Bhavnagar.			

The following gives the arrangement of the ports according to the method or system of storm signals adopted:—

ARABIAN SEA PORTS.

I.—By extended system.	*II.—By brief system.*	
Kurrachee.	Cutch-Mandvi.	Ratnagiri.
Bombay.	Jamnagar.	Malwan.
Mormugao.	Dwarka.	Goa.
Mangalore.	Porbandar.	Vengurla.
Tellichery.	Veraval.	Karwar.
Calicut.	Jafrabad.	Kumta.
Cochin.	Bhavnagar.	Honavar.
	Daman.	
	Alibag.	
	Murud-Janjira.	

Four storms visited the Arabian Sea during the year. The first occurred during the fourth week of May and was of considerable intensity: it caused the loss of some small boats in the Bombay harbour. The second was a dangerous cyclone which formed in the third week of June and caused very stormy weather with winds of hurricane strength. The remaining two storms were of slight to moderate vigour and did not influence weather in the Arabian Sea to any great extent.

66. The storm warning work was, on the whole, carried out satisfactorily by the warning officers at Simla and Calcutta. Ample and early definite warning was, so far as I can judge, given in the case of all the more important storms which visited the coasts of India in 1903-04. In the case of the May storm the warning signal was hoisted at Bombay, but not the danger signal although the storm was close to the port. According to the present code the danger signal would imply that the storm was about to cross the coast and it was correctly predicted that this would not happen.

FLOOD WARNINGS AND WEATHER FORECASTS TO DISTRICT OFFICERS, IRRIGATION AND OTHER OFFICERS OF THE PUBLIC WORKS DEPARTMENT AND TO EXPEDITIONS IN THE FIELD.

67. This work is chiefly carried out by the Simla Meteorological Office. The arrangements for it have been sanctioned at various times, and differ

considerably in character, depending upon the nature and extent of the flood or weather warnings required by the officers concerned. The common feature of the work is that individual officers receive special warning telegrams when necessary, in order to enable them to take precautionary measures for the safety of the works or of the district under their charge.

68. Warnings of heavy rain likely to give rise to serious floods in the Nerbudda, Tapti, Sabarmati or Mahi rivers are sent to twelve officers in the districts of Gujarat, Kathiawar, Bombay and Khandesh. Telegrams are sent by the Simla office warning these officers of the existence of storms likely to give heavy rain and severe floods, and the meteorological observers at Hoshangabad, Jubbulpore, Khandwa, Pachmarhi, Amraoti, Akola and Chikalda telegraph directly to the same officers the actual occurrence of heavy rain at their respective stations.

69. The arrangements by which weather and flood warning telegrams are sent to certain Public Works, Railway and Irrigation officers were fully stated in pages 30—31 of the Administration Report for 1889-90. In some cases, the officers concerned require telegrams warning them of advancing storms likely to give heavy rain; in other cases, they require telegrams giving information of actual heavy rainfall in the hill districts likely to give rise to severe floods which might injure the railways or canal works in the submontane districts under their charge; and in others, they require warnings or forecasts of the weather for as long a period beforehand as possible, so as to enable them to modify their arrangements for carrying on the works under their charge so far as may be necessitated by sudden or large changes of weather.

70. The number of district officers and officers in the Irrigation, Railway and Public Works Departments requiring warnings amounted at the end of the year to 67.

71. The list of officers warned does not include captains of mail steamers and other vessels who occasionally telegraph from Kurrachee, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

72. The number of special warning messages sent last year was 847, as compared with 759 in 1902-03 and 745 in the year before.

73. Warnings of floods or of heavy rainfall were issued by the Bengal Reporter to seventeen officers of the Public Works and other Departments, chiefly in the province of Bengal.

74. Instructions were issued five years ago by the Government of India that every officer to whom storm or flood warnings are issued, should in the month of January of each year or, in the case of military expeditions, at the close of the campaign, forward to the Meteorological Reporter to the Government of India a brief return of the warnings received during the past year and should also report:—

(1) Whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

(2) Whether the warnings were timely and satisfactory in every respect and, if not, in what points they were defective.

(3) Whether any changes might be made in the system which would make the warnings more useful and effective.

75. Opinions were received in all from 45 officers. Forty officers stated that the warnings they had received were timely and satisfactory or had no suggestions to make for the improvement of the system. The Port Officer, Akyab, and the Commissioner of Orissa Division, Cuttack, complained of the delay in the transmission of the warning telegrams. The Executive Engineer, Rawalpindi, pointed out that the warnings of coming rain would be of more value than notices of past rain. The Collector of Salt Revenue, Bombay, Camp Ratnagiri, suggests that a signal station might be established at Harnai.

76. Every effort is being made to improve the flood warning telegrams, but in some districts in India, more especially the Punjab, it is very difficult to forecast

with approximate accuracy the occurrence of heavy rain more than 12 to 24 hours before its actual occurrence.

PUBLICATIONS.

A.—WEATHER REPORTS.

77. ***India Weather Reports.***—The following weather reports, giving information of the current weather to the Government and the Public, were published during the year by the India Meteorological Office :—

(1) India Daily Weather Report and Chart.

(2) India Weekly Weather Report, giving an account of the weather and of the rainfall of the week ending on the previous Thursday, published in the *Gazette of India* every Saturday.

(3) India Monthly Weather Review, giving a general summary and a full review of all the important features of the weather and complete meteorological data of the month.

India Daily Weather Report and Chart.—The number of stations for which data were given in the daily report of the 31st of March 1903 was 164 and in that of the 31st March 1904, 166.

The Daily Weather Report was issued on March 31st, 1904, to 459 recipients, or 24 more than on the same date in the previous year.

India Weekly Weather Report.—The Weekly Weather Report was published in the *Gazette of India* in the same form as in the previous year. During the cold weather this report and tabular statement is telegraphed from Simla to Calcutta in time for publication in the *Gazette*.

India Monthly Weather Review.—There has been no change in the form or matter of this publication during the year under report.

The following gives the dates of issue of the parts of the Monthly Weather Review for the past year:—

		Date of Issue.				*Date of Issue.*	
April	1903.	2nd September	1903	October	1903.	28th March	1904.
May	„	22nd October	„	November	„	4th May	„
June	„	18th November	„	December	„	19th May	„
July	„	14th December	„	January	1904.	3rd August	„
August	„	26th January	1904.	February	„	15th August	„
September	„	13th February	„	March	„	15th September	„

Annual Summaries.—The annual summary of the meteorology of India for 1902 supplementing the Monthly Weather Reviews for that year, was issued on the 19th November 1903. It contains mean data for the year 1902 and a discussion of the more important meteorological features of the year and of their relations to each other. A summary of the meteorology of the year 1902 was prepared for the Sanitary Commissioner with the Government of India, and was given as Chapter I of the Annual Report of that officer for the year 1902.

Special Charts.—The Simla office prepared, throughout the year, weekly charts (drawn by hand) showing the character of the rainfall of each week and of the seasonal rainfall up to date, for the use of His Excellency the Viceroy, His Majesty's Under-Secretary of State for India, London, and the Secretary to the Government of India in the Revenue and Agricultural Department. Similar charts were also forwarded to the Lieutenant-General Commanding the Forces in Bengal, Naini Tal, throughout the year.

The Calcutta office of the India Meteorological Department prepared four series of average seasonal rainfall charts and annual rainfall charts of the whole of India, as in previous years, for the information of the Government of India and the Secretary of State.

78. ***Provincial Weather Reports.***—The following provincial reports were issued by the provincial Reporters during the year :—

(1) By the Bengal Reporter—

(*a*) Bay of Bengal Daily Weather Report and Chart issued during April, November and December 1903, and January to March 1904.

(*b*) Bengal Daily Weather Report and Chart issued during the period May to October 1903.

(*c*) Monthly Rainfall Table for Bengal and Meteorological Table for Bengal and Assam, with a summary of the chief features of the weather of the month published in the *Calcutta Gazette.*

(*d*) Report on the meteorology of Bengal for the monsoon season of 1903, illustrated with rainfall maps.

(*e*) Charts showing the distribution of actual rainfall, the departure from the normal and the percentage departure were prepared monthly during the period May to October 1903, and submitted to the Government of Bengal and the Sanitary Commissioner, Bengal.

(2) By the Bombay Reporter—

(*a*) Bombay Daily Weather Report and Chart.

(*b*) Monthly abstracts of meteorological observations published in the Bombay Government *Gazette.*

(3) By the Madras Reporter—

(*a*) Madras Daily Weather Report and Chart.

(*b*) Monthly Rainfall Table for Madras, Coorg, Pudukota, Cochin and Travancore published in the Provincial *Gazette.*

(4) By the Meteorological Reporter to the Government of the United Provinces of Agra and Oudh—

(*a*) Monthly Weather Summary of the province published in the Provincial *Gazette.*

(*b*) Brief sketch of the meteorology of the province for the year 1902-03.

(*c*) Monthly Rainfall Table for the United Provinces of Agra and Oudh, published in the Provincial *Gazette.*

(5) By the Meteorological Reporter for the Punjab—

(*a*) Monthly summary of the weather of the Punjab, published in the Provincial *Gazette.*

(*b*) Annual meteorological summary of the Punjab for the year 1902-03.

The short annual report on the meteorology of Bengal formerly submitted by the Meteorological Reporter to the Government of Bengal has been discontinued under orders of that Government.

B.—Indian Meteorological Memoirs.

79. The following were issued during the year :—

(1) Summary and a brief discussion of observations of the clouds recorded at six stations in India, during the period 1895—1900, by Sir John Eliot, M.A., F.R S., K.C.I.E., (late) Meteorological Reporter to the Government of India and Director-General of Indian Observatories. (Indian Meteorological Memoirs, Vol. XV, Part I.)

(2) Report on cloud observations and measurements at Simla during the period June 1900 to January 1902, by W. L. Dallas, Esqr., Scientific Assistant to the Meteorological Reporter to the Government of India,(Indian Meteorological Memoirs, Vol. XV, Part II.)

(3) Monthly normals of air pressure reduced to 32° F. and constant gravity, Lat. 45°, by Sir John Eliot, M.A., F.R.S., K.C.I.E., (late)

Meteorological Reporter to the Government of India and Director-General of Indian Observatories. (Indian Meteorological Memoirs, Vol. XVI, Part I.)

80. The following have been or will be issued during the year 1904-05 :—

(1) Discussion of monthly mean surface and underground temperatures deduced from observations taken at Lahore, Jaipur, Dehra Dun, Allahabad and Calcutta during the years 1880—1901, by R. Ll. Jones, M.A., F.R.A.S., Meteorological Reporter to the Government of Madras.

(2) Normal monthly and annual means of temperature, pressure, wind, humidity cloud, rainfall and number of rainy days of stations in India, etc., by Sir John Eliot, M.A., F.R.S., K.C.I.E., (late) Meteorological Reporter to the Government of India and Director-General of Indian Observatories.

(3) A preliminary investigation of the more important features of the meteorology of Southern Asia, the Indian Ocean and neighbouring countries during the period 1892—1902 by Sir John Eliot, M.A., F.R.S., K.C.I E.

C.—Other Publications.

81. The Government of India has sanctioned the publication of a Meteorological and Climatological Atlas of India; the work has been undertaken by Sir John Eliot and will be published by Messrs. J. Bartholomew & Co., Edinburgh.

Meteorological Offices.

82. The India Meteorological Office and the Alipore Central Observatory are now placed in buildings in the same compound at Alipore, an arrangement which has considerably improved the character of the work in both offices. The Simla Meteorological Office which forms virtually a part of the Central office, issues the India Daily Weather Report and the India Weekly Weather Report and carries out an increasing amount of the ordinary current and special work of the head office, such as preparing data for the Monthly Weather Reviews, for the Annual Summary and for special memoirs.

83. In addition to the Imperial Meteorological offices at Alipore (Calcutta) and Simla, there are Provincial Meteorological offices at Allahabad, Bombay, Calcutta and Madras.

84. Six hundred and eighty-three books and pamphlets were added to the Library during the year which were either purchased or presented by scientific bodies. The Library is in fair order.

85. Sixteen libraries and foreign observatories and societies were added during the year 1903-04, to the list of institutions to which the publications of the India Meteorological Department are supplied, bringing the number on the list up to 361.

Concluding Remarks.

86. The Meteorological Department received valuable assistance in its work from the Survey, Telegraph and Postal Departments during the year.

87. The Telegraph Department has continued to assist the Department by the rapid transmission of storm and flood-warning telegrams during the year. There are in all twenty-nine observatories established at Departmental Telegraph offices, the observations being taken either by the telegraph master or by a signaller, and all worked satisfactorily during the year except Akyab, Chittagong, Hyderabad (Sind) and Kurrachee.

88. By permission of the Postal Department, meteorological observatories are established at seventeen combined Postal and Telegraph offices. Observations at the great majority of these stations are taken by one of the telegraph signallers, but in one or two cases they are recorded by the postmasters. All

these observatories, with the exception of Bahraich and Mainpuri, worked satisfactorily during the year.

89. Daily weather telegrams from Aden were sent free of charge to Bombay by the Eastern Telegraph Company during the year, and were thence forwarded as ordinary service weather telegrams to Simla, where they usually arrived, during the year, about one and-a-half hours after despatch from Aden. The Department is greatly indebted to the Eastern Telegraph Company for this valuable concession.

90. The observatories at Jask, Teheran, Muscat and Ispahan, where there are telegraph offices on the Indo-European telegraph line, furnished valuable observations during the year. Daily weather telegrams were transmitted, free of cost, to the Department to Kurrachee from Bushire and Jask throughout the whole year, from Ispahan and Teheran throughout the cold weather, from the 16th November 1903 to the 31st March 1904, and from Muscat from the 18th May 1903 onwards. These telegrams were forwarded from Kurrachee to Simla in the same manner as ordinary Indian weather telegrams. They were very useful in forecasting the approach of cold weather storms from Persia to Northern India. The Department is greatly indebted to the Directors of the Persian Gulf Section and the Persian Section for the continuance of this most valuable concession during the year.

91. Weekly telegrams were received during the south-west monsoon period from the Royal Alfred Observatory, Mauritius, and also from the departmental observatories at Zanzibar and the Seychelles. These telegrams gave valuable information during the south-west monsoon period of the weather conditions in the Indian Ocean and the Department is indebted to the officers for their punctual transmission of the telegrams and more especially to the Director of the Royal Alfred Observatory, for his courtesy in placing the meteorological data of that observatory at the disposal of the India Meteorological Department.

92. The Department is greatly indebted for very important information as to the meteorological conditions in South Africa antecedent to the south-west monsoon to Mr. Hutchins, Conservator of Forests, Cape Colony, and also for special information to the Public Works Department and Sir William Willcocks, Cairo, and to J. McClounie, Esq., head of the Scientific Department, Zomba, British Central Africa. The information received was utilised in the preparation of the south-west monsoon forecast issued in the first week of June.

93. The co-operation of the Provincial Reporters, more especially Messrs. Dallas, Hill, Jones and Kenyon, and of Mr. Küchler, Assistant Meteorological Reporter in charge of the Central Observatory at Alipore, has contributed largely to the progress of the Department during the past year.

94. Mr. W. A. Bion, First Assistant, and Lala Hem Raj, Second Assistant, in the India Meteorological Office, Simla, have both done excellent work throughout the year.

95. I desire to place on record the names of the following subordinate officers in the Simla and Calcutta Meteorological offices, who have done good service during the past year:—

(1) Rai Sahib Fanindra Mohan Basu, Head Clerk of the Calcutta Central Meteorological office.
(2) Babu Allah Bakhsh, Head Clerk of the Simla Meteorological office.
(3) Babu Nirduksha Kumar Ghosh, Chief Computer of Calcutta Central Meteorological office.
(4) Babu Nirbhai Singh, Computer of the Simla Meteorological office.

GILBERT T. WALKER,

Meteorological Reporter to the Government of India and Director-General of Indian Observatories.

METEOROLOGICAL OFFICE, INDIA;
Alipore (Calcutta), the 21st August 1904.

G. I. C. P. O.—No. 485 Meteor.—12-10-04.—280.

REPORT

ON

THE ADMINISTRATION

OF

THE METEOROLOGICAL DEPARTMENT

OF

THE GOVERNMENT OF INDIA

IN

1906-07.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

DEPARTMENTAL CHANGES DURING THE YEAR 1906-07.

Temporary and Permanent changes in the staff.

1. Dr. Gilbert T. Walker, Director General of Observatories, returned from privilege combined with deputation leave extending in all over 3 months and 12 days, and took over charge of the Department on the forenoon of the 30th April 1906 from Mr. J. Patterson, who officiated for him during his absence.

2. Mr. W. L. Dallas, Imperial Meteorologist, retired from service on the forenoon of the 8th November 1906 and Dr. G. C. Simpson had been appointed Imperial Meteorologist *vice* Mr. W. L. Dallas. He arrived at Bombay on the afternoon of the 24th November 1906, and joined the Department at Simla on the 28th November 1906.

3. Mr. J. Patterson, Imperial Meteorologist, Simla, proceeded on privilege combined with deputation leave for 2 months and 27 days, on the 28th of March 1907, and Mr. W. A. Bion, First Assistant, Simla Meteorological Office, officiated for him.

4. Mr. C. W. Peake, Professor of the Presidency College, Calcutta, was appointed Meteorologist, Calcutta, from the afternoon of the 26th April 1906, relieving Mr. J. A. Cunningham.

5. Dr. E. G. Hill, Professor in the Muir Central College, Allahabad, on return from leave took over charge of the office of the Meteorologist, Allahabad, from Mr. J. J. Durack on the forenoon of the 23rd November 1906.

6. Mr. J. Evershed was appointed to the Meteorological Department as Assistant Director, Kodaikanal Observatory, with effect from the 20th January 1907, and arrived at Kodaikanal on the 21st January 1907.

Changes regarding the designation of the Gazetted Officers and Departmental procedure.

7. On the 27th December 1905, a circular had been sent by the Imperial Government to the Governments of Madras, Bombay, Bengal, the United Provinces of

LI OF BO

and the Punjab inviting their attention to certain points of procedure relating to the local Meteorological Reporters, and especially in connection with the filling up of vacancies, payment when on leave and the submission of administration reports; it was also suggested that the tabulation of rainfall statistics should be effected in the office of the Director of Land Records in all cases, this being already the practice in most provinces. It was pointed out that the names of the local meteorological officers had not been changed since 1875 when it was determined that the meteorological work of the country should be coordinated under one head, and it was suggested that in order to remove possible misapprehension the designations of these officers should be altered.

8. On the 30th August 1906 a second circular was issued stating that the Local Governments consulted had accepted the proposals of the previous circular, except in some matters of detail. The duties of the local officers were decided, and the method of procedure for filling up vacancies was laid down; it was also determined that the allowances during periods of leave were to be available for the *locum tenens*, and that the administration reports of the local meteorologists were to be forwarded to the head of the department for submission to the Local Governments concerned together with his remarks. The designations of the Gazetted officers were changed in the following manner:—

Old designation.	New designation.
1. Meteorological Reporter to the Government of India and Director-General of Indian Observatories.	1. Director-General of Observatories.
2. 1st Scientific Assistant and Meteorological Reporter to the Government of the Punjab.	2. Imperial Meteorologist.
3. Deputy Meteorologist	3. Imperial Meteorologist.
4. Deputy Meteorologist	4. Imperial Meteorologist.
5. 2nd Scientific Assistant and Meteorological Reporter to the Government of Bengal.	5. Meteorologist, Calcutta.
6. Meteorological Reporter to the Government of the United Provinces.	6. Meteorologist, Allahabad.
7. Meteorological Reporter to the Government of Bombay.	7. Meteorologist, Bombay.
8. Meteorological Reporter to the Government of Madras and Deputy Director of the Madras Observatory.	8. Meteorologist, Madras, and Deputy Director of the Madras Observatory.

OBSERVATORIES.

9. The observatories maintained by the Government of India are classified as follows:—

First class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, rainfall, and wind direction and velocity, in addition to instruments read by eye.

Second class.—Observatories at which readings are taken daily at 8 hrs. 10 hrs. and 16 hrs: those at 8 hrs. are (with a few exceptions) transmitted by telegram to Simla, Calcutta, Bombay or Madras for inclusion in the India or provincial Daily Weather Reports.

Third class.—Observatories—

(*a*) where readings are taken daily at 8 hrs. only; in those stations where there are telegraph offices the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports;

(*b*) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determination of monthly and daily means which should be comparable with the means already obtained for second class observatories.

Fourth class.—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only, are recorded.

10. At the commencement of the year 261 observatories contributed registers of meteorological data; of these 46 were non-departmental and 215 were maintained by the Government of India. At the end of the year the total number of observatories was 265, of which 46 were non-departmental and 219 were maintained by the Government of India.

Of the 219 departmental observatories, 7 were first class, 40 second class, 152 third class and 20 fourth class.

11. The changes in non-departmental observatories during the year were the following:—

(1) a third class observatory was opened at Pusa on the 1st August 1906, under the superintendence of the Director of the Agricultural Research Institute and Principal of the Agricultural College, Pusa;

(2) a fourth class observatory was opened at Fraserganj on the 21st May 1906, under the superintendence of the Commissioner in the Sunderbans;

(3) the fourth class observatory at Yatung was closed after the 31st December 1906;

(4) the observatory at Muktesar was changed from non-departmental to departmenal.

12. The following are the changes in departmental observatories during the year under review:—

(1) third class observatories were opened at Pharijong, Gyantse, Calingapatam and Robat on the 8th April 1906, the 7th June 1906, the 23rd July 1906 and the 24th January 1907, respectively, and on board the P. V. *Fraser* on the 19th September 1906;

(2) the second class observatory at Ranikhet was closed on the 31st May 1906;

(3) the third class observatory at Wellington was closed on the 31st May 1906;

(4) the observatory at Cocos Island was changed from third to fourth class on the 1st April 1906, only anemographic observations being recorded there, and all the other instruments were transferred to Slipper Island where a third class observatory was established.

13. Observations have been received from Chumbi and from Dthala recorded from instruments which were supplied to officers of the Tibet and Aden Missions, respectively.

First Class Observatories.

14. The Directors of the Government Observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded through the

Department for the information of Government. It has accordingly been ruled that it is unnecessary to include information relating to the working of these observatories in the present Administration Report.

15. *The Alipore Observatory.*—This observatory is under the charge of the Meteorologist, Calcutta. It is furnished with a complete set of autographic instruments, including a Whipple-Casella sunshine recorder, a Callendar sunshine recorder, a Bergholz barograph, a Kew barograph, a Kew thermograph, a Richard thermograph, a Beckley anemograph, a Dines pressure-tube anemometer, a Beckley rain-gauge, a Michie Smith monthly rain-gauge, a Mascart self-registering electrometer and a Milne horizontal pendulum seismograph.

These instruments have on the whole worked satisfactorily during the past year.

16. All instruments issued by the Meteorological Department are carefully tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 589 as compared with 370 last year. Forty-four instruments were condemned as unfit for issue or were sent for repair to the Mathematical Instrument Department and three instruments were kept in store for future treatment.

17. The observatory gives mean Calcutta time to the port and shipping. Three time balls were dropped daily at 1 P.M. local mean time during the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore Docks.

This work was carried out rather less satisfactorily than in previous years. There were 25 failures as compared with the average number 10·8 of the past eighteen years; in all cases except one they were due to faulty behaviour of the electric or mechanical arrangements outside the office.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failure due to telegraphic defects.
1906-1907	25	24
1905-1906	11	11
1904-1905	3	3
1903-1904	20	20
1902-1903	14	14
1901-1902	13	13
1900-1901	15	15
1899-1900	13	13
1898-1899	6	6
Mean of ten years, 1888-98	10	10

18. *The Allahabad Observatory.*—This observatory is under the charge of the Meteorologist, Allahabad. The self-recording instruments, in use at the observatory were:—(1) a Beckley anemograph; (2) Two Dines pressure tube anemometers situated on the top of a tower at a height of 55 feet above the ground level; (3) a Richard barograph; (4) a Richard thermograph (giving both wet and dry bulb records); (5) a Draper thermograph (dry bulb only); and (6) a Stokes sunshine recorder.

There were also in use at the observatory (1) four solar radiation thermometers; (2) a grass thermometer for measuring terrestrial radiation; (3) one ground thermometer placed on the surface; (4) the ordinary complement of instruments for eye observations of atmospheric pressure, temperature, vapour pressure, humidity, cloud, wind and rainfall; (5) six barometers for purposes of

comparison and for use in the inspection of observatories; (6) a Marie Davy and a Duboscq nephoscope; (7) and a full set of ordinary thermometers in the new cage which was set up last year and faces north.

Beckley anemograph.—The instrument seems to have worked well throughout the year, except on nine occasions when short breaks occurred in the trace.

Dines pressure anemometer.—There are two instruments in work. One worked fairly satisfactorily and the second one, which gave lower wind values, was found to have too light a float. It has now been corrected and is under observation.

Richard barograph.—This instrument gave excellent tracings throughout the year. All the charts have been tabulated.

Richard thermograph.—The wet bulb tracings of the thermograph have not been very satisfactory, but the dry bulb tracings, with a few exceptions, have been good. There were no breaks in the records of the instruments.

Draper thermograph.—This instrument gave no records from 13 hour of the 22nd August to 10 hour of the 23rd of the same month, owing to the breaking of the pen. It worked well through the other months of the year.

Sunshine recorder.—This gave good results without break.

Nephoscope—Regular observations of clouds have been made with the large Marie Davy and Duboscq instruments.

Readings of all the eye instruments were taken every two hours, from 6 hours to 22 hours. The earth thermometer on the surface was read at 6, 14 and 22 hours. Special observations for use in storm warnings were made when they were called for by the Simla office.

19. *The Lahore Observatory.*—Eye observations of the ordinary meteorological instruments have been taken seven times daily at this observatory as in past years; that is at 6, 8, 10, 14, 16, 18 and 22 hours.

The observatory is furnished with the following automatic instruments which have worked satisfactorily during the year.

(1) Draper barograph; (2) Richard barograph; (3) Casella self-recording raingauge; (4) Beckley anemograph; (5) sunshine recorder.

The Draper thermograph and Draper sun thermometer remained in use till the end of July 1906 when they were discontinued.

Besides the above instruments there are in use at the observatory three maximum solar radiation thermometers, one ordinary sun thermometer (not self-registering), one grass radiation thermometer and one ground-surface thermometer.

The following permanent changes were made in the establishment of the Lahore Observatory:—

Babu Jaspat Rai, Chief Observer, died on the 22nd May 1906 and the Second Observer was promoted to the post of the Chief Observer with effect from the 1st August; the Third Observer was promoted to the post of Second Observer. The Third Observer's post was abolished.

On the abolition of the post of the Third Observer a slight reduction in the work of the observatory was made. The use of the Draper thermograph and Draper sun thermometer was discontinued, and the tabulation of the records of not only these instruments but also of the Draper barograph and Richard barograph ceased to be made at Lahore.

Character of the work of observation at Second and Third Class Observatories.

20. The general character of the work of the observatories has again showed a marked improvement. The number of stations of extreme reliability, in which either no mistake or only one has been detected in the data for the Indian Daily Weather Report, was 14 in 1905-06 and has been 22 in 1906-07; the number of

satisfactory stations where the number of errors has been less than twenty has increased from 117 to 132; and the number of very unsatisfactory stations has decreased from five to four. The latter were Hoshangabad, Jalpaiguri, Jask, and Ludhiana, at each of which the number of errors exceeded 50; Jalpaiguri and Jask occurred in the corresponding class last year.

The usual list showing the number of observations rejected, and also the number of telegrams incorrectly prepared, for all the observatories which send weather telegrams to the Simla office, was prepared and circulated to the observatories at the end of the year under review.

Inspection of Observatories.

21. The number of visits paid to observatories during the year was 85 as compared with 73 in the previous year and an average of 77 during the past eight years.

The Director-General inspected the observatories at Calcutta, Bombay, Madras and Kodaikanal. Mr. Patterson inspected thirteen stations mainly on the west coast and discussed improvements in the flood and storm warning with a number of officials. Mr. Field went to Ceylon in order to confer with the head of their Meteorological Service, to compare the standard barometer at Colombo with the Calcutta standard, and to see their observatories: he also visited Mount Abu in order to choose a new site for the thermometer shed. Dr. Simpson inspected twenty-one stations. Mr. Gaetane inspected twenty-five, Lala Hem Raj eleven, Ganesh Sadashiv five and Kalipada Banerjee three.

Six observatories were inspected twice so that the actual number of established ones visited was 79: of these 32 were reported as good, 36 as fair, 6 as tolerable and 5 as bad.

The corresponding numbers last year were 27, 21, 13 and 4.

Condition.	Number of observatories inspected in						
	1906-1907.	1905-1906	1904-1905.	1903-1904.	1902-1903.	1901-1902.	1900-1901.
Good or satisfactory ...	68	48	58	45	55	61	53
Tolerable	6	13	13	22	21	12	33
Bad	5	4	5	2	10	9	13
Total ...	79	65	76	69	86	82	99

Of the eleven observatories classed as other than satisfactory the defects could only be said to be due to the carelessness of the observer at Jalpaiguri; at the other stations defective exposure or other conditions over which this department has little control were responsible for the unsatisfactory reports.

22. The work of inspection is not yet so fully carried out as I should like to see it. More frequent inspection of observatories, especially those established in connection with hospitals, dispensaries and post offices, is desirable, on account of the occasional changes of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments. The Postal Department has issued a circular directing that in all cases where it is feasible time should be given to train the new observer before the old observer leaves the station: but occasionally these directions are not or cannot be observed.

Special Observations.

23. Observations beyond those recorded at regular intervals are made as follows:—

(*a*) In response to requests from the Simla or Calcutta office when weather is disturbed and storm warnings may have to be issued: such observations are always sent by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Re. 1 for each set of special observations sent at the request of either Simla or Calcutta. The number of telegrams of the latter class forwarded during this year was 817 as compared with 394 sent last year.

(*b*) Certain observers have been empowered, when they consider that conditions at sea are sufficiently threatening, to send of their own initiative to Simla or Calcutta a telegram containing special observations. One occasion of this type occurred.

(*c*) In connection with flood warning a number of observers have been instructed to send telegrams announcing the occurrence of heavy rainfall to Government officers and railway engineers who desire early information. The number of telegrams so sent was 87 compared with 49 last year.

(*d*) After earthquakes, observers are instructed to send information in as definite a form as is possible: 61 reports were sent during the year.

Observations with Special Meteorological Instruments.

24 The following special observations were carried out during the past year at certain selected stations:—

1st.—Wind observations recorded by Beckley anemographs at 18 stations and by Dines pressure tube anemometers at seven stations.

2nd.—Solar and terrestrial radiation observations at ten and at eleven stations respectively.

3rd.—Underground temperature observations at 2 stations.

4th.—Sunshine observations at 10 stations.

5th.—Barometric observations recorded by self-registering instruments, chiefly Richard barographs, at 46 stations.

6th.—Thermometric observations recorded by self-registering instruments, chiefly Richard thermographs, at 40 stations.

25. Richard barographs were supplied to Fraserganj and Veraval; and the Dines pressure tube anemometer at Cocanada, and the thermographs at Lahore and Saugor Island were withdrawn.

Work with Balloons and Kites.

26. Further work with kites has been done during the year, and information has been obtained of the air conditions in the Peninsula, previous to, and during the monsoon, from the ground level up to a height of 11,000 feet above sea. During May the hand winding machine previously used at Karachi was taken to Belgaum and eleven ascents were made with it; and during August a power-winding machine with a 3 H. P. Tangye oil engine was brought into use there. These latter are now housed at Belgaum in a hut which has been built for the purpose of kite flying on the top of a hill about 3 miles out of Belgaum; it is intended to use them for 3 or 4 weeks annually for some years during the monsoon period. The results of the year's kite flying are in course of preparation for publication in the Indian Meteorological Memoirs.

Methods of working with small balloons have been improved during the year, and a number of flights have been made from Simla. These have been

observed from the ends of a base line by means of theodolites and measurements of wind directions and velocities up to a height of 58,000 feet above sea level have been secured. The balloons as now made are of light gutta percha tissue, of spherical shape six feet in diameter, with a weight of slightly over a pound.

Seismograph Observations.

27. Seismological observations were recorded by means of Milne's self-registering seismograph during the year, as in previous years, at Alipore (Calcutta), Kodaikanal and Colaba (Bombay), and by means of other self-registering instruments at the last named station. All the instruments worked satisfactorily throughout the year, and the records of the Milne's seismographs were regularly transmitted to the Seismological Committee of the British Association.

At Simla also there is a seismograph, of Omori-Ewing pattern ; this has been in use throughout the year and records of the severe earthquakes which have occurred throughout the world during the year have been obtained with it.

Atmospheric Electricity.

28. Observations on the number of free ions in the atmosphere were made with Ebert's aspiration apparatus at Simla during several months of the year, at Belgaum in August, and along the west coast from Cochin to Karachi in December during a tour of inspection.

Marine Meteorology.

29. Considerable changes had been made in this work during the year 1905-06. It had been felt that less was to be gained by prolonging the detailed examination for eleven years of the northern part of the Indian Ocean than by attempting to gain insight into the conditions over the whole Indian Ocean, and especially over the southern region of high pressure, where the monsoon winds derive their origin: and it had been decided to extend the area under observation to Cape Town on the west, Australia on the east and Kerguelen Island on the south.

In the hope of obtaining an adequate amount of information it had been decided to supplement the logs obtained from Calcutta and Bombay by all that could be collected from London, Washington, Hamburg and Mauritius. As regards Calcutta and Bombay the methods formerly in use have been continued in their entirety. A clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard for the purpose of applying the necessary correction to the readings of the logs. The number of ships visited is materially less than that of the vessels which come into port but it is ample for our purposes: and after the barometer comparisons have been tabulated in the Calcutta or Bombay office the error of the ship's barometer is posted to the captain in case he should desire to make use of it.

The information relating to the area in question in logs collected in England is copied and sent to Simla by the London Meteorological office, and in return this department has undertaken to assist as far as it can in the production of their charts of the Indian Ocean. The Weather Bureau at Washington and the Royal Alfred Observatory at Mauritius have very kindly forwarded to us their original meteorological logs in quarterly batches; these are promptly copied and returned by us. In the case of Hamburg arrangements have been made whereby copies of the logs are made there, the expense being borne by this Department. Cordial thanks are due to all four offices for the assistance given.

30. It had for some time been anticipated that the number of readings available would not be sufficient to enable daily maps to be prepared, but it had been hoped that by combining the observations made during each month there might

have been enough material for a satisfactory map giving the mean pressure and wind distribution during this period. Experience has shown that this is not the case; the data are not in any part of the map sufficiently numerous for the errors of observation to cut each other out, and over a large part of the area the amount of information is completely inadequate. The preparation of charts of the Indian Ocean has thus been suspended, but the data from Bombay and Calcutta are still being utilized for the preparation of daily charts of the Arabian Sea and Bay of Bengal during periods of disturbed weather.

The issue of pilot charts giving, month by month, the normal meteorological conditions over the Indian seas and the Indian Ocean as far south as Lat. 12° S., was continued. These charts show the mean pressure, the mean direction and force of the wind, the mean surface currents and the ordinary tracks of storms in the month under review, together with a brief synopsis of the normal conditions of the month.

The chart for each month was issued about the 15th of the month preceding the period to which it referred. A charge of four annas was made for each copy. The total monthly issue amounts to about 160 copies.

It had been decided to alter the method of publication of these charts and instead of issuing them month by month, with annual repetition, to issue a small atlas containing the twelve monthly charts of normal conditions and such additional charts of special conditions as it might be thought desirable in order to make the atlas as useful as possible. The calculation of the necessary data and the preparation of the charts had been completed during the year 1905-06 and the results are now being printed by Messrs. Bartholomew of Edinburgh.

31. At Calcutta and Bombay it had been the practice that after the comparison of the barometer of any ship had been checked in the Meteorological office a statement of the error of the barometer was posted to the captain in case he should wish to make use of it. There appeared to be evidence on the part of some captains of a desire for earlier information as to the errors of their instruments, and arrangements were made during the year for the correct height of the barometer at 8 hrs. to be published in the chief local newspapers; the clerks who visit the vessels were also instructed to give information in future as to the result of the comparisons of the barometers before they leave the vessels.

32. Observations recorded during the year at the entrance to the River Hooghly were supplied to the Meteorological Department by the light vessels *Torch* at the Ridge station, *Planet* at the Upper Gasper station, *Canopus* at the Lower Gasper station and *Star* at the Intermediate station.

Snowfall Registration in the Mountain Districts to the North and West of India.

33. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas for the cold weather of 1906-07 was on the whole tolerably complete and the thanks of the Department are due to the various officers who have collected and forwarded snowfall information during the past winter. It is in many cases to be feared, however, that while the reports provided may represent faithfully the impressions of subordinate officers, they cannot be relied upon for that accurate comparison of one year with another which is desirable in the interest of climatic study. Important and reliable additions to the information have been obtained by continuing the series of large-scale photographs of the snows as seen from Simla which had been started in 1905.

Rainfall Registration.

34. No change was made in the system of rainfall registration during the year under review. A full account of the methods employed, which came into full operation during the year 1891-92, will be found in pages 5—8 of the Administration Report of the year 1889-90, or in pages 6, 7 of the Administration Report of the year 1890-91.

35. The following is a classified statement of the total number of rain-gauge stations at the end of the year in the various political divisions of the empire, and of the number of rain-gauge stations of which inspection reports were received by the Indian Meteorological Office during the year 1906-07 :—

Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1907.	Number of inspections of rain-gauges in 1906-7 of which copies of the reports were rrceived in the Simla Meteorological Office.				Percentage of inspections of which copies of reports were received to total number of rain-gauges.
		Good.	Fair.	Bad.	Total.	
Eastern Bengal and Assam ...	229	41	12	...	53	23
Baluchistan	62	...	...	...	...	...
Bengal	308	78	13	3	94	31
Bombay and Sind	337	...	...	...	...	...
Burma	183	19	11	1	31	17
Central India	112	...	...	...	...	...
Central Provinces and Berar ...	169	50	3	...	53	31
Hyderabad	22	...	...	...	...	...
Kashmir	37	...	...	...	...	...
Madras (including Pudukkottai, Coorg, Travancore and Cochin).	491	260	94	11	365	74
Mysore	77	...	...	...	...	...
North-West Frontier Province ...	32	...	...	...	...	...
Punjab	188	43	7	1	51	27
Rajputana	179	20	1	1	22	12
United Provinces of Agra and Oudh ...	289	25	5	...	30	10
Total ...	2,715	536	146	17	699	...

Note.—In several cases the same gauge was inspected more than once during the year.

36. The registration of rainfall in India has invariably been carried out by the provincial authorities and in the larger provinces under the general Control of the Boards of Revenue. Previous to 1889 the hours and arrangements for the registration of rainfall differed largely in different provinces. In 1889 a uniform system was introduced by the Government of India, and the Director General of Observatories was made consulting officer in connection with this work. The local officers superintend the registration of rainfall and submit brief annual administrative reports to their respective Governments, copies of which should be forwarded to the head of this department.

The following paragraphs give a brief summary of the reports of rainfall registration for the year 1906-07 submitted to the various Local Governments and Administrations by these local officers.

37. *Baluchistan.*—No report has been received.

38. *Bengal.*—Stations were started during the year at Khunti, Amrapura, Chandrakona, Bhagwanpur, Puri Jail; and the total number of rain-gauges on the 31st March 1907 was 309. During the year 148 gauges were inspected.

The returns from Yatung, Tibet, were not received after January 1907; and correspondence has been started with the Chinese Commissioner of Customs with reference to the matter. Fourteen stations did not submit rainfall returns regularly, and one submitted returns in a very careless manner.

39. *Bombay.*—The total number in the Presidency, including Sind, of rain-gauge stations, which reported rainfall to this office was 337, the same as in the preceding year.

Out of the total of 276 rain-gauges in the British Districts 216, or 78 per cent., as against 196, or 71 per cent., last year came under inspection; 99 of these were inspected more than once and the total number of inspections amounted to 347 as against 308 in the previous year. Sufficient attention was not paid to this inspection in one district each in Deccan, Karnatak, Konkan and Gujarat, and the attention of the Collectors concerned is being invited to it by the local Government.

40. *Burma.*—The number of rain-recording stations in the province is 183, of which 14 are meteorological observatories and 22 are under the charge of the Public Works Department. Six new stations were opened during the year. The number of gauges inspected was 166, of which 118 are reported to be in good condition, 47 in fair state and one in bad. The monthly rainfall returns were punctually received except in the cases of some stations where delays are unavoidable owing to difficulties of communication.

41. *Central India.*—No report has been received.

42. *Central Provinces and Berar.*—The number of rain-gauges maintained during the year in the Central Provinces* was 105 against 95 in the previous year. Of this number 9 are observatories under the control of the Meteorological Department and of the 96 remaining 23 are managed by the Medical Department, 15 are maintained by Feudatory States and 58 are either in charge of kanungos, police muharrirs or schoolmasters. The total number of inspections made of the rain-recording stations in the Central Provinces aggregated 132 against 121, in the preceding year and 76 in the year 1904-05.

The number of rain-gauges in Berar during the year remained the same, namely 44. Of this number 4 are observatories under the control of the Meteorological Department and of the remainder 37 are managed by civil surgeons and hospital assistants and 3 by tahsildars. No rain-gauge station was established or abolished during the year, and the situation of the rain-gauges remained the same.

The number of inspections made of the rain-gauge stations during the year was 124 against 125 in 1905-06.

43. *Eastern Bengal and Assam.*—The total number of stations on the 31st March, 1907, was 229, *viz.*, 107 in the Eastern Bengal and 122 in the Assam districts, against 106 and 118 respectively in the preceding year. Five new stations were started during the year, namely, one in Jalpaiguri, one in Lushai Hills and 3 in Goalpara district. Of the 229 gauges only 56 were inspected during the year.

44. *Hyderabad.*—No report has been received.

45. *Kashmir.*—No report has been received.

46. *Madras.*—On the 31st March, 1906, there were 463 rain-recording stations excluding the meteorological observatories furnishing rainfall returns for publication in the Fort St. George Gazette. To these three more were added and one closed during the year; so that on 31st March 1907, there were 465 Revenue Board rain stations and 26 meteorological observatories furnishing rainfall returns. Of this total 390 are in the Madras Presidency and 356 or 91 per cent. were inspected during the year. In January, 1907, a list of rain-gauge stations not inspected or reported on since 1st April, 1906, was sent to the Collectors and the Assistant Commissioners of Salt, Abkari and Customs Department with a request that, if possible, these stations should be inspected before the end of the official year. All the stations in the Nellore, Trichinopoly, South Canara, Salem, Cuddapah and Bellary districts have been inspected, and the inspections in the other districts are almost equally satisfactory. All the defects noticed have been or are being rectified. Forty-three indents for rain-gauges, glass measures, &c., were received and submitted to the Imperial Meteorological

* Other than those under the Irrigation Department.

Office for compliance : while 17 sets of village rain-gauges for Tanjore, 12 sets for Kurnool, 62 sets for North Arcot, 12 sets for Salem, 20 sets for Ganjam, 24 sets to the Chatram villages (Tanjore District) and 200 sets for Chingleput were made under the supervision of this office at Madras and supplied.

47. *Mysore.*—There was considerable improvement in the number of rain-gauge inspections during the year the total being 177 out of 209 or 85 per cent., as compared with 155 out of 204 or 76 per cent. in the previous year.

48. *North-West Frontier Province.*—No report has been received.

49. *Punjab.*—There are 188 rain registering stations, of which 40 are in the charge of the Canal Department and 148 are under Civil Officers. The stations are the same as they were last year except that the site of one gauge in the Gujranwala District has been changed. It is reported that one or more of the gauges has been inspected by superior officers in most districts. The gauges are in good order and the records are properly kept.

50. *Rajputana.*—No report has been received.

51. *United Provinces of Agra and Oudh.*—There are now 289 rain reporting stations in these provinces, including the meteorological observatories, all of which use gauges of the Symons pattern.

Out of the 275 stations under district and canal officers' supervision, 158, or nearly 58 per cent., were reported as inspected during the year under review. Some of these were inspected more than once. In 14 districts all the gauges were inspected, in 7 districts one station only in each was inspected and in 4 districts no inspections were made.

The inspections of rain-gauges were more carefully made during the year under report than in previous years. In a number of cases the sites on the ground level were found unsuitable and it became necessary to transfer the gauges to the roofs of buildings.

Two stations, Khannah and Manikpur, in the Banda district, and one, Kousanie, in Almora, were started during the year in report. No station was closed.

Measurements are made at the established time of 8 hrs. everywhere except at stations under the control of Executive Engineers of the Cawnpore division, Ganges Canal, and the Dun Canals, where for convenience 6 hours has been adopted. The Local Government are taking steps in relation to this anomaly.

52. *Summary.*—The work of rainfall registration is steadily improving and extending, and is satisfactorily carried out over nearly the whole Empire.

In the absence of complete returns it is difficult to arrive at a satisfactory conclusion regarding inspection. In Bombay, Burma, the Central Provinces, Madras and Mysore the work has been carried out very thoroughly, while in Eastern Bengal and Assam the amount of inspection has been decidedly limited.

Seasonal Forecasts.

53. In May 1906 it was decided that seasonal forecasts should no longer be confidential as they had been since the forecast of the cold weather precipitation of 1901-02. The forecast for the monsoon period of 1906, dated the 9th June, was accordingly sent to Local Governments and Administrations, communicated to the press and printed in the Gazette. The statement of the rainfall of June and July with a forecast for August and September was drawn up on the 8th August and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was drawn up on the 11th February 1907 and sent to Local Governments and Administrations.

The result of the comparison of the June forecast was as follows :—

The forecast for June and July was correct in its indication that rainfall would on the whole be least abundant in the northern half of the field of the Bombay current, but the total monsoon rainfall of India proved to be materially

larger than had been anticipated. It would appear from the character of the local distribution that the effect of the heavy sub-equatorial rainfall had been rightly interpreted, but it had not been foreseen that the pressure distribution in the southern Indian Ocean, after being nearly normal in May, would become very favourable indeed in June to Indian rainfall and that the monthly pressure averages at Mauritius would remain favourable throughout the monsoon period.

The summary of the comparison of the August forecast was that the anticipations were vague but were fairly correct.

54. A memorandum on the weather during October and November, 1906, with a forecast of the rainfall in northern India and of the snowfall on the neighbouring mountain areas during the cold weather of 1906-07, was prepared on the 5th December and issued in the same manner as the forecast of the previous June. A statement of the actual precipitation and a comparison with the anticipations has since been issued.

It had been pointed out in the forecast that the indications were conflicting, that no reliable inferences therefore were possible, and that there was no reason for expecting any large departure from normal conditions. As a matter of fact the season was milder than usual in December and January, but then changed completely and became very severe, so that the total precipitation was in large excess.

Storm Warnings.

55. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed by two officers. Ports on the Bay of Bengal are warned from the Calcutta Office by the Meteorologist, Calcutta, and ports on the Arabian Sea from the Simla Office by the Director General of Observatories or by one of his assistants.

The complete system at present in operation includes :—

1st.—An extended system of storm signals for use at the larger and more important ports.

2nd.—A brief system of storm signals for use at the smaller ports, chiefly for the information of native vessels and local traffic.

56. *Bay of Bengal Storm Signal Service*.—The following is a list of the ports for the warning of which during the year 1906-07 the Meteorologist, Calcutta, was responsible :—

Mergui.	Chittagong.	Vizagapatam.	Tuticorin.
Tavoy.	Narayanganj	Cocanada.	Colombo.
Moulmein.	Calcutta and River Hooghly.	Masulipatam.	
Rangoon.	Balasore.	Madras.	
Bassein.	Chandbali.	Cuddalore.	
Akyab.	False Point.	Negapatam.	
	Puri.	Pamban.	
	Gopalpur.		
	Calingapatam.		

Telegraphic information is also sent to Chittagong, Narayanganj and the Orissa ports whenever storm signals are hoisted at Saugor Island.

It may be noted that in the case of the Bengal ports the signals are hoisted by the direct orders of the Meteorologist, Calcutta. In the case of the Burma and Coromandel coast ports, the storm signals are hoisted by the orders of the Port Officers, acting on information respecting the path and intensity of the storms received at short intervals during their progress from the Meteorologist, Calcutta.

57. Storm signals were hoisted on eight occasions and various ports were warned by cautionary signals on seven occasions during the storm season. The weather was disturbed by depressions on nineteen occasions but only once did the depression develop into a severe storm, while none developed into a cyclone.

There are also special arrangements at Calcutta for supplying daily to Saugor Island and to certain ports in the Bay information as to the state of the weather

in the Bay at 8 A M. for the benefit of shipping. This information is given partly by a system of flag signal messages indicating generally the state of the weather in four sections of the Bay and partly by means of a special code telegram in which the information is of a more detailed character.

The places at which flag signals are hoisted and to which code telegrams are also sent are Rangoon, Chittagong, Vizagapatam, Cocanada, Madras, Cuddalore, Negapatam and Porto Novo. Flag signals only are hoisted at Saugor Island and Elephant Point (Rangoon), while code telegrams are sent to Moulmein, Akyab and Gopalpur ; code telegrams are also sent to Calingapatam on Sundays, Wednesdays and Thursdays.

On the 21st January 1907 the Government of India sanctioned the discontinuance of the daily weather telegrams and flag signals to all ports, with the exception of Saugor Island, during the period from the 15th January to 31st March : the decision was based on the fact that at this time weather in the Bay is very rarely disturbed. Vizagapatam has been added during the year to the list of ports receiving daily weather telegrams.

These arrangements worked satisfactorily and occasionally gave information of much value to the mail and coasting steamers of the British India and other shipping companies.

58 *Arabian Sea Storm Signal Service.*—The work of warning the Arabian Sea ports was carried out during the past year by the Simla Meteorological Office which also warned the Madras ports on the Malabar coast in the same manner as the Meteorologist, Calcutta, warned the Madras ports on the coast of the Bay of Bengal. Warnings of storms in the Arabian Sea were also sent to the Port Officer, Aden, for the information of steamers leaving that port for Colombo, Bombay and Kurrachee. Copies of all warnings sent to the Malabar ports were forwarded for information to the Master Attendant, Colombo; the Commercial Agent to the Diwan of Alleppi ; the Presidency Port Officer, Madras ; the Deputy Port Conservator, Madras ; and the Chief Engineer for Irrigation, Madras.

The following is a list of the Bombay and Malabar ports for the warning of which during the year 1906-07 the Simla Meteorological Office was responsible :—

I.—By extended system.	*II.—By brief system.*	
Kurrachee.	Cutch-Mandvi.	Murud-Janjira.
Bombay.	Jamnagar.	Ratnagiri.
Mormugão.	Dwarka.	Harnai.
Mangalore.	Porbandar.	Malwan.
Tellichery.	Veraval.	Goa.
Calicut.	Jafrabad.	Vengurla.
Cochin.	Bhavnagar.	Karwar.
	Daman.	Kumta.
	Alibag.	Honavar.

59. Weather was disturbed off the west coast in October : the Malabar ports were warned on the 18th and cautionary signals were hoisted from Honavar to Kurrachee on the 22nd ; they were all lowered by the 27th. This was the only period of disturbed weather in the Arabian Sea, but on the 22nd June and again on the 27th August it was considered probable that strong winds would be experienced in the sea owing to the presence of a depression inland. Cautionary signals were accordingly hoisted on the first occasion at Kurrachee and on the second at Kurrachee and Bombay, and were lowered on the 24th June and 29th August respectively.

Flood warnings and weather forecasts to District Officers, Irrigation and other Officers of the Public Works Department and to Expeditions in the Field.

60. This work is carried out chiefly by the Simla Meteorological Office and partly by that of Calcutta. The arrangements for it have been sanctioned at various times, and differ considerably in character, depending upon the nature and extent of the flood or weather warnings required by the officers concerned. In some cases the officers concerned require telegrams warning them of advancing storms likely to give heavy rain ; in other cases they require telegrams giving information of actual heavy rainfall in the hill districts, likely to give rise to severe floods which might injure the railways or canal works in the submontane districts under their charge ; and in others they require warnings or forecasts of the weather for as long a period beforehand as possible, so as to enable them to modify their arrangements for carrying on the works under their charge so far as may be necessitated by sudden or large changes of weather.

61. Warnings of heavy rain likely to give rise to serious floods in the Nerbudda, Tapti, Subarmati or Mahi rivers are sent to twelve officers in the districts of Gujarat, Kathiawar, Bombay and Khandesh. Telegrams are sent by the Simla office warning these officers of the existence of storms likely to give heavy rain and severe floods, and the meteorological observers at Hoshangabad, Jubbulpore, Khandwa, Pachmarhi, Amraoti, Akola and Chikalda telegraph directly to the same officers the actual occurrence of heavy rain at their respective stations.

62. Arrangements have been in force for sometime whereby telegrams recording heavy rain in the Punjab and neighbouring districts were sent to certain selected officers of the North-Western Railway to warn them of the probability of floods on different parts of the line. In order to save the time occupied by the transmission of the weather messages to Simla and the re transmission of their contents to the railway officials concerned, it has been arranged that whenever there is a fall of 2″ of rain in 24 hours at Simla, Chakrata, Sialkot, Murree, Peshawar, Cherat, Srinagar or Gulmarg, information of the occurrence shall be telegraphed direct by the meteorological observers at those stations to the railway officials concerned.

63. The number of district officers and officers in the Irrigation, Railway and Public Works Departments requiring warnings from Simla amounted at the end of the year to 81.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Kurrachee, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

The number of special warning messages sent during the year 1906-07, was 990, as compared with 554 in 1905-06 and 569 in the year before.

64. Warnings of floods or of heavy rainfall were issued by the Meteorologist, Calcutta to sixteen officers of the Public Works, Telegraphs and other Departments, chiefly in Bengal and on the east coast.

65. Instructions were issued seven years ago by the Government of India that every officer to whom storm or flood warnings are issued, should in the month of January of each year, or in the case of military expeditions at the close of the campaign, forward to the head of this department a brief return of the warnings received during the past year and should also report :—

(1) Whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

(2) Whether the warnings were timely and satisfactory in every respect and, if not, in what points they were defective.

(3) Whether any changes might be made in the system which would make the warnings more useful.

66. Reports on the storm and flood warnings for the year 1906 were received from fifty officers. Of these twenty-nine reported that the warnings were timely and satisfactory and were rapidly transmitted by the Telegraph Department. Fifteen officers, chiefly in Baluchistan and Bengal, gave the actual conditions for the periods for which warnings were given, indicating that the warnings were on the whole satisfactory, although in a few cases the kind of weather warned for was not experienced. Two officers did not receive on one occasion the warning telegram that was despatched to them. Three officers made no comments, and in the case of three others no occasion arose for sending warnings.

The Executive Engineer, North-Western Railway, Rawalpindi District, reports that the telegrams were rapidly transmitted and in two cases they were useful, but of no great advantage, while in the other two cases they were unsatisfactory: he makes no suggestions for their improvement.

The Port Officer at False Point states that the telegrams were satisfactory but did not give timely warning in every case as the telegrams were delayed in transmission, especially those despatched at night.

One officer reported that the warnings would be of more use if they could be despatched earlier but the others provided no suggestions for improvement.

Transmission of messages from the Andamans by wireless telegraphy.

67. Arrangements were made in 1905 for the transmission by wireless telegraphy of the 8 hrs. observations from Port Blair and Slipper Island and of special observations, in the case of unsettled conditions in the Bay of Bengal.

In spite of the troubles from external disturbances usually experienced with wireless telegraphy in periods of stormy weather the installation at the Andamans has but seldom failed, and the information that it has conveyed has proved of the greatest value in connection with the daily weather reports of Simla, Calcutta and Madras, as well as in the more important work of warning for storms in the Bay.

Daily weather telegraphic summary.

68. The changes made last year by which it became possible to despatch the daily telegraphic summary at 12·30 instead of 14 hours have worked satisfactorily, and a further rearrangement within the office has led to an acceleration of half an hour, so that the time of despatch is now noon.

The summary is now posted at telegraph offices, is sent to 78 servants of Government, to 7 subscribing newspapers and to 4 private subscribers.

Publications.

A.—Weather Reports.

69. *India Weather Reports*.—The following weather reports, giving information of the current weather to the Government and the public, were published during the year by the Simla Meteorological Office:—

(1) India Daily Weather Report.

(2) India Weekly Weather Report, giving an account of the weather and of the rainfall of the week ending on the previous Thursday, published in the *Gazette of India* every Saturday.

(3) India Monthly Weather Review, giving a general summary of all the important features of the weather and complete meteorological data of the month.

(4) Annual Summary of the Monthly Weather Reviews.

India Daily Weather Report.—The number of stations for which data were given in the daily report of the 31st of March 1906 was 169, and in that of the 31st March 1907, 173.

The Daily Weather Report was issued on March 31st, 1907, to 501 recipients or 24 more than on the same date in the previous year.

Several improvements were introduced during the year, chief of which was the description of the day's weather in separate paragraphs for five large geographical divisions so that those desiring information regarding any definite part of the country would know where to look for it.

India Weekly Weather Report.—The Weekly Weather Report was published in the *Gazette of India* in the same form as in the previous year. During the cold weather this report and tabular statement are telegraphed from Simla to Calcutta in time for publication in the *Gazette.*

India Monthly Weather Review.—It is of considerable importance in order to facilitate the application of meteorological data to administrative, commercial or agricultural ends that the divisions for which the data are calculated should be suitably selected ; and the number of systems in use in the department had been very greatly in excess of the real requirements, a number of entirely different boundaries being used for the Daily Weather Report and Weekly Weather Summary, the Monthly Weather Review, the Annual Summary and the rainfall returns to the Secretary of State. After thorough discussion with other departments interested in climatic data it was proposed that the number of systems should be reduced to two, of which one should consist of the main political areas and in the other these should be subdivided when on meteorological grounds there appeared to be sufficient reason. It was accordingly decided to postpone the publication of the Monthly Weather Review for January 1907 and subsequent months until a decision on the system of divisions had been reached.

Owing to the fact that these Reviews contain rainfall data based on returns from about 2,500 stations sent on by the Local Governments, it is inevitable that there should be a considerable delay in its appearance, and its value for administrative purposes is thereby very greatly diminished. A Monthly Supplement to the Daily Weather Report which is published two or three days after the close of the month with which it deals, has therefore been initiated and appears to be found useful. It contains a short account of the weather of the month and a tabular statement of temperature, cloud, humidity and rainfall, based on the telegraphic information of the Daily Weather Report.

Annual Summaries.—The annual summary of the meteorology of India for 1905 supplementing the Monthly Weather Reviews for that year, was issued in July 1907. It contains mean data for the year and a discussion of its more important meteorological features together with their relations to each other. A summary of the meteorology of the year 1905 was prepared for the Sanitary Commissioner with the Government of India, and was given as Chapter I of the Annual Report of that officer for the year 1905.

Special Charts.—The Simla office prepared, throughout the year, weekly charts showing the character of the rainfall of each week and of the seasonal rainfall up to date, for the use of His Excellency the Viceroy, His Majesty's Under-Secretary of State for India, London, and the Secretary to the Government of India in the Revenue and Agricultural Department. Similar charts were also forwarded to the Lieutenant-General Commanding the Forces in Bengal, Naini Tal, throughout the year.

The Calcutta office of the India Meteorological Department prepared four series of seasonal rainfall charts and annual rainfall charts of the whole of India, as in previous years, for the information of the Government of India and the Secretary of State.

70. *Provincial Weather Reports.*—The following provincial reports were issued by the provincial reporters during the year :—

(1) By the Calcutta Meteorologist.

(*a*) Bay of Bengal and Bengal Daily Weather Report. In this changes were introduced similar to those made in the India Daily Weather Report.

(*b*) Monthly Rainfall Table for Bengal and Meteorological Table for Bengal and Assam, with a summary of the chief features of the weather of the month, published in the *Calcutta Gazette* for April, May, and June.

(*c*) Meteorological Table for Bengal and Assam, with a summary of the chief features of the weather for the month published in the *Calcutta Gazette* from July onwards.

The Government of Bengal agreed that the report on the Meteorology of Bengal for the monsoon period and the monthly rainfall table for Bengal previously prepared by the Bengal Reporter should be prepared by the Director of Agriculture, Bengal.

(2) By the Bombay Meteorologist.

(*a*) Bombay Daily Weather Report.

Negotiations with the object of improving this report have been entered upon with the Bombay Government and the Bombay Chamber of Commerce. In addition to the regular daily telegrams certain information about rainfall is given bi-weekly and it is proposed to obtain this from a larger number of representative stations as well as to increase the number of existing departmental observatories whose daily observations are telegraphed to Bombay for inclusion in the Report.

(*b*) Monthly, abstracts of meteorological observations published in the Bombay Government *Gazette*.

(3) By the Madras Meteorologist—

(*a*) Madras Daily Weather Report.

(*b*) Monthly Rainfall Tables for Madras, Coorg, Pudukkottai, Cochin and Travancore published in the Provincial *Gazette*.

(4) By the Allahabad Meteorologist—

(*a*) Monthly Weather Summary of the province published in the Provincial *Gazette*.

(*b*) Brief sketch of the meteorology of the province for the year 1905.

(*c*) Monthly Rainfall Tables for the United Provinces of Agra and Oudh, published in the Provincial *Gazette*.

(5) By the Simla Office—

(*a*) Monthly summary of the weather of the Punjab, published in the Provincial *Gazette*.

(*b*) Annual meteorological summary of the Punjab for the year 1905-06.

B.—Memoirs of the Indian Meteorological Department.

71. The following has been published during the year 1906-07:—

(1) An account of the preparations made for determining the conditions of the upper air in India by means of kites, by J. H. Field, Esq. B.A., Deputy Meteorologist (Memoirs of the Indian Meteorological Department, Vol. XX, Part I).

72. The following have been under preparation during the year 1906-07, and have been published since—

(1) A discussion of the anemographic observations recorded at Rangoon from June 1878 to October 1901, and a discussion of the anemographic observations recorded at Chittagong from June 1879 to December 1896, by Sir John Eliot, M.A., F.R.S., K.C.I.E., late Meteorological Reporter to the Government of India and Director-General of Indian Observatories. (Memoirs of the Indian Meteorological Department, Vol. XVIII, Part I).

(2) A discussion of the anemographic observations recorded at Saugor Island from March 1880 to February 1904, and a discussion of the anemographic observations recorded at Alipore (Calcutta) from March 1877, to February 1904, by Sir John Eliot, M.A., F.R.S., K.C.I.E., late Meteorological Reporter to the Government of India and Director-General of Indian Observatories. (Memoirs of the Indian Meteorological Department, Vol. XVIII, Part II).

73. Considerable progress has also been made with a number of other wind memoirs by Sir John Eliot, which will shortly be published.

C.—Other Publications.

74. The following have been published during the year 1906-07 : —

(*a*) Climatological Atlas of India. :—This had been prepared by Sir John Eliot and was published by Messrs. Bartholomew of Edinburgh.

(*b*) Telegraphic Code and instructions for the use of the Indian Meteorological Department (6th Edition).

75. The following have been under preparation during the year 1906-07 :—

(*a*) A Meteorological Atlas of the Indian Seas and the North Indian Ocean has been prepared by Mr. W. L. Dallas and is being published by Messrs. Bartholomew.

(*b*) Appendix to the Handbook of Observatories. A collection of facts for departmental reference.

Meteorological Offices.

76. The Simla Meteorological office which now is the central office issues the India Daily Weather Report and the India Weekly Weather Report, and carries out an increasing amount of the ordinary administrational and special work of the head office, such as preparing data for the Monthly Weather Reviews, for the Annual Summary and for special memoirs. The India and Bengal Meteorological Offices and the Alipore Central Observatory are now placed in buildings in the same compound at Alipore, an arrangement which has considerably improved the character of the work in all three offices.

77. A number of mechanical appliances have been installed at Simla and the equipment is now adequate for the making and repairing of some of the apparatus which would otherwise have to be effected in Europe. Additions to the equipment of scientific apparatus have also been made.

78. In addition to the Imperial meteorological offices at Simla and Alipore (Calcutta) there are Provincial meteorological offices at Allahabad, Bombay and Madras.

79. Fourteen hundred and twenty-eight books and pamphlets either purchased or presented by scientific bodies were added to the Library during the year. The Library is on the whole in fair order.

80. Eight libraries, observatories or societies were added during the year to the list of institutions to which the publications of the India Meteorological Department are supplied, and one was removed; the number on the list is now 365.

Chief features of the year.

81. It was pointed out last year that the addition of two gazetted officers to the staff had made it possible to exercise closer supervision over the work of the ordinary observers of the Department, and it is satisfactory to notice now a marked improvement both in the accuracy of their work (paragraph 20) and in the condition of the observatories (paragraph 21). Among our difficulties in connection with storm and flood warning has been the lack of precise information as to when warnings were required and what form they should take : and a beginning has been made with a systematic attempt to obtain this information

and to get into closer touch with the officers concerned. Of this one result has been a large increase in the number of telegrams sent [paragraphs 23 (*a*), (*c*), 63].

The area from which meteorological information is derived has been widened by the opening of new stations at Pharijong and Gyantse in Tibet and at Robat close to the Persian Frontier. New stations also at Calingapatam and on the P. V. *Fraser*, with the last of which there is connection by wireless telegraphy, will be of value in following the movements of storms in the Bay.

In the method of distribution of weather information to the public the chief change has been the introduction of the monthly Summary of the Daily Weather Report, which gives an abstract of the month's weather with a tabular statement two or three days after the conclusion of the month (paragraph 69). Improvements have been made in the Simla and Calcutta Weather Reports and are in prospect in that of Bombay.

The climatological atlas of India which had been prepared by Sir John Eliot was published by Messrs. Bartholomew in July 1906 and is probably the finest work of the kind that has as yet been produced : Sir John Eliot is now engaged upon a series of memoirs upon the winds of representative stations in India and upon a meteorological handbook of India, which is much required by those seeking information in a form that is easily available. The meteorological atlas of the northern Indian Ocean is still in the press.

Progress has been made in the more purely scientific work of the department. The first actual measurement of the thickness of the monsoon current has been made at Belgaum, and the observations of air currents made by means of balloons at Simla have been extended to a height of 58,000 feet above sea level. Measurements have also been instituted at Simla of various electrical quantities associated with the air, and of the sun's radiation. As regards the larger air movements over the earth, on which the amount of monsoon rainfall depends, a number of new facts have been obtained empirically, and these are being studied by statistical methods in order to find the relations between them and their influence upon the monsoon currents.

Concluding Remarks.

82. The Meteorological Department received valuable assistance in its work from the Survey, Telegraph and Postal Departments during the year.

83. The Telegraph Department has continued to assist the Department by the rapid transmission of daily weather, and of storm and flood warning telegrams. There are in all 28 observatories established at Departmental Telegraph Offices, the observations being taken either by the Telegraph Master or by a signaller, and except at a few stations the observations were satisfactory throughout the year.

84. By permission of the Postal Department meteorological observatories are established at eighteen combined Postal and Telegraph offices. Observations at the great majority of these stations are taken by one of the telegraph signallers, but in one or two cases by the Postmasters. With certain exceptions these observatories also worked satisfactorily during the year.

85. Daily weather telegrams from Aden were sent free of charge to Bombay by the Eastern Telegraph Company during the year and the Department is greatly indebted to the Eastern Telegraph Department for this valuable concession as well as for the rapid transmission of the messages.

86. The observatories at Jask, Teheran, Muscat and Ispahan, where there are telegraphic offices on the Indo-European Telegraph line, furnished valuable observations during the year. Daily weather telegrams were transmitted, free of cost to the Department, to Kurrachee from Bushire and Jask throughout the year and from Ispahan, Teheran and Baghdad from the 16th November 1906 to the end of the official year. These telegrams were forwarded from Kurrachee to Simla in the same manner as Indian weather telegrams, and were very useful in forecasting the approach of cold weather storms from Persia to northern India. The Department is greatly indebted to the Directors of the Persian Gulf Section and of the Persian Section of the Indo-European telegraph line for the continuance of this valuable concession.

87. Weekly telegrams were received from the 12th May to the 1st December 1906, from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams gave valuable information of the weather conditions in the Indian Ocean and the Department is indebted to the officers for the punctual transmission of the information. Thanks are more especially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the India Meteorological Department.

88. The Department is greatly indebted, for important information as to meteorological conditions prevailing antecedent to and during the south-west monsoon, to Mr. Hutchins, Conservator of Forests, Cape Colony; the Director of the Government Observatory, Durban; Mr. J. McClounie, head of the Scientific Department, Zomba, British Central Africa; the Meteorologist, Dar-es-Salaam; His Majesty's Commissioner, Entebbe, Uganda; the Director-General, Survey Department, Cairo; the Director of the Government Observatory, Perth; the Government Astronomer, Adelaide; the Government Astronomer, Sydney; the Director of the Central Nicolas Physical Observatory, St. Petersburg (for information as to Siberian conditions); the Directors of the Observatories at Buenos Ayres and Santiago; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

GILBERT T. WALKER,

Director-General of Observatories.

METEOROLOGICAL OFFICE; SIMLA,

The 9th September, 1907.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

G. C. B. P., Simla.—No. 271 M. R. G. I—28-9-07.—280.—N.C.

REPORT

ON

THE ADMINISTRATION

OF

THE METEOROLOGICAL DEPARTMENT

OF

THE GOVERNMENT OF INDIA

IN

1907-08.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

1. The department has to regret the death, which occurred on 18th March 1908, of Sir John Eliot, F. R. S., K. C. I. E., the late Meteorological Reporter to the Government of India and Director General of Indian Observatories. Sir John Eliot had been officially engaged from the time of his retirement in 1903 on the preparation of departmental records for publication in the form of Memoirs, and during the year he completed the publication of his analysis of winds at Rangoon, Chittagong, Allahabad and Lucknow. At the time of his death he had still in hand the preparation of several other Meteorological Memoirs and a "Handbook of the Meteorology of India" as a companion volume to the Climatological Atlas which appeared in 1906. Throughout the long term of seventeen years of his office as Meteorological Reporter to the Government of India, Sir John Eliot showed a wholehearted concern for the interests, usefulness and development of the department. A short account of his meteorological work in India was given in the Administration Report for 1903-04.

DEPARTMENTAL CHANGES DURING THE YEAR 1907-08.

Temporary changes in the staff.

2. Mr. J. Patterson, Imperial Meteorologist, returned from privilege combined with deputation leave extending in all to 2 months and 27 days (the deputation period being from the 16th May to the 6th June 1907), and took over charge of his duties on the forenoon of the 24th June 1907 from Mr. W. A. Bion, who had officiated for him during his absence.

3. Mr. J. H. Field, Imperial Meteorologist, proceeded on 13 days deputation combined with 2 months and 27 days privilege leave from 23rd August 1907, and returned to duty on the forenoon of the 2nd December 1907, relieving Mr. W. A. Bion, who had officiated for him during his absence.

4. Mr. C. Michie Smith, Director, Kodaikanal and Madras Observatories, returned from 3 months' privilege leave combined with 6 months' furlough (total 9 months) and took over charge of the Directorship on the forenoon of the 2nd January 1908, from Mr. J. Evershed, who had officiated for him during his absence.

5. Mr. R. Ll. Jones, Meteorologist, Madras, and Deputy Director of the Madras Observatory, proceeded on 14 months' furlough combined with and in continuation of the summer vacation (from 6th May until 8th July 1907), of the Presidency College, Madras; and Mr. R. Littlehailes, Professor of Mathematics in the Presidency College, Madras, was appointed to officiate for Mr. Jones during his absence.

OBSERVATORIES.

6. The observatories maintained by the Government of India are classified as follows :—

First Class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, and wind direction and velocity, in addition to instruments read by eye.

Second Class.—Observatories at which readings are taken daily at 8 hrs., 10 hrs. and 16 hrs.: those at 8 hrs. are (with a few exceptions) transmitted by telegram to one or more of the offices at Simla, Calcutta, Bombay or Madras for inclusion in the India or provincial Daily Weather Reports.

Third Class.—Observatories—

(*a*) where readings are taken daily at 8 hrs. only ; in those stations where there are telegraph offices the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports ;

(*b*) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only ; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determination of monthly and daily means which should be comparable with the means already obtained for second class observatories.

Fourth Class.—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only, are recorded.

7. At the commencement of the year 265 observatories contributed registers of meteorological data ; of these 46 were non-departmental and 219 were maintained by the Government of India. At the end of the year the total number of observatories was 272, of which 49 were non-departmental and 223 were maintained by the Government of India.

Of the 223 departmental observatories, 7 were first class, 22 second class, 174 third class and 20 fourth class.

8. The changes in non-departmental observatories during the year were the following :—

(*1*) 4th class observatories were opened (1) at Birjand (in Persia) on the 1st April 1907, under the superintendence of the officer on special duty in Eastern Persia ; (2) at Kermanshah (in Persia) on the 1st January 1908 under the superintendence of His Britannic Majesty's Consul; and (3) at Kargil (in Kashmir) on the 1st January 1908, under the superintendence of the Meteorological Reporter, Jammu and Kashmir State, Srinagar.

(*2*) The observatories at Ambala and Meshed were changed from non-departmental to departmental on the 1st April 1907, and 1st June 1907, respectively.

(*3*) The observatories at Chitaldroog and Hassan were changed from 2nd to 3rd class on the 1st and 18th August 1907, respectively.

(*4*) Arrangements were made for recording and wiring to Simla the observations at 7 hrs. from Colombo and Trincomalee (from 6th and 7th March 1908, respectively), instead of at 8 hrs. as was previously done, and the observer at each of the stations was granted an allowance of Rs. 5 per month from the department on account of the change.

9. The following were the changes in departmental observatories during the year :—

(*1*) A third class observatory was opened at Monghyr on the 10th April 1907 and another on the 15th October 1907 at Kerman, Persia, under the superintendence of His Britannic Majesty's Consul at that station.

(*2*) The observatories at the following stations were changed from 2nd to 3rd class :—

(*a*) Ludhiana, Khandwa, Roorkee, Karwar, Peshawar, Jacobabad, Hazaribagh, Waltair, Salem, Bellary, Deesa, Sholapur and Akola on the 1st July 1907.

(*b*) Diamond Island, Saugor Island, Chittagong, False Point and Akyab on the 1st March 1908.

(*3*) The observatory at Buldana was changed from 3rd (*b*) to 3rd (*a*) class on the 1st January 1908.

10. Observations were received from D'thala, Mauritius, Beirut, Singapur and Penang. (These are not included in the total number of stations in paragraph 6.) Meteorological instruments were supplied to Gartok, Ahwaz Shiraz, Turbat-i-Haidari, Kotgarh and Goona.

11. Owing to the difficulty of checking effectively the 10 h. and 16 h. observations from 2nd class observatories, which were few in number and by many years of work had afforded fairly completely the information required from them, it was decided to reduce all second class observatories to 3rd class with the exception of those at hill stations, the observations of which are required for the investigation of the upper atmosphere, and those at the chief towns of their districts which are retained for climatological purposes. It was in accordance with this policy that the changes given in detail in paragraph 9 (2) (*a*)and (*b*) above were made.

First Class Observatories.

12. The Directors of the Government Observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded through the Department for the information of Government. It has accordingly been ruled that it is unnecessary to include information relating to the working of these observatories in the present Administration Report.

13. *The Alipore Observatory.*—This observatory is under the charge of the Meteorologist, Calcutta. It is furnished with a complete set of autographic instruments, including a Whipple-Casella sunshine recorder, a Callendar sunshine recorder, a Bergholz barograph, a Kew barograph, a Kew thermograph, a Richard thermograph, a Beckley anemograph, a Dines pressure-tube anemometer, a Beckley rain-gauge, a Michie Smith monthly rain-gauge, a Mascart self-registering electrometer and a Milne horizontal pendulum seismograph.

These instruments have on the whole worked satisfactorily during the past year, except the Callendar sunshine recorder, which was out of order.

14. All instruments issued by the Meteorological Department are tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 503 as compared with 589 last year. Thirty-three instruments were condemned as unfit for issue or were rapaired by the Mathematical Instrument Department or the Departmental Mechanic and twenty-two instruments were kept in store for future treatment.

15. The observatory gives mean Calcutta time to the port and shipping. Three time balls are dropped daily at 1 P.M. local mean time throughout the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore Docks.

This work was carried out satisfactorily on the whole. There were 10 failures as compared with the average number 11·6 of the past nineteen years;

in all cases they were due to faulty behaviour of the electric or mechanical arrangements outside the observatory.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1907-1908	10	10
1906-1907	25	24
1905-1906	11	11
1904-1905	3	3
1903-1904	20	20
1902-1903	14	14
1901-1902	13	13
1900-1901	15	15
1899-1900	13	13
1898-1899	6	6
Mean of ten years, 1888-98	10	10

16. *The Allahabad Observatory.*—This observatory is under the charge of the Meteorologist, Allahabad. The self-recording instruments in use at the observatory were:—(1) a Beckley anemograph; (2) Two Dines pressure tube anemometers situated on the top of a tower at a height of 55 feet above the ground level; (3) a Richard barograph; (4) a Richard thermograph (giving both wet and dry bulb records); (5) a Draper thermograph (dry bulb only); and (6) a Stokes sunshine recorder.

There were also in use at the observatory (1) three solar radiation thermometers; (2) a grass thermometer for measuring terrestrial radiation; (3) one ground thermometer placed on the surface; (4) the ordinary complement of instruments for eye observations of atmospheric pressure, temperature, vapour pressure, humidity, cloud, wind and rainfall; (5) six barometers for purposes of comparison and for use in the inspection of observatories; (6) a Marie Davy and a Duboscq nephoscope; (7) and a full set of ordinary thermometers in a second cage for purposes of comparison.

Beckley anemograph.—The instrument seems to have worked well throughout the year, except on seven occasions when short breaks occurred in the trace, and on one occasion when the instrument was under repair for a week.

Dines pressure anemometer.—There are two instruments in work, both of which gave good tracings but there is some difference between the simultaneous values of wind pressure recorded by them; they are however still under experiment.

Richard barograph.—This instrument gave excellent tracings throughout the year. All the charts have been tabulated.

Richard thermograph.—The wet bulb tracings of the thermograph have not been very satisfactory, but the dry bulb tracings, with a few exceptions, have been good.

Draper thermograph.—Observations with this instrument were permanently discontinued on the 19th September.

Sunshine recorder.—This gave good results without a break.

Nephoscope.—Regular observations of clouds have been made with the large Marie Davy and Duboscq instruments.

Readings of all the eye instruments were taken every two hours, from 6 h. to 22 h. The earth thermometer on the surface was read at 6, 14 and 22 h. Special observations for use in storm warnings were made when they were called for by the Simla office.

17. *The Lahore Observatory.*—Eye observations of the ordinary meteorological instruments were taken seven times daily at this observatory as in past years; that is at 6, 8, 10, 14, 16, 18 and 22 h. Ground surface temperature was recorded four times daily, *viz.*, 6, 10, 16 and 22 h.

The observatory is furnished with the following automatic instruments which have worked satisfactorily during the year:—

(1) Draper barograph; (2) Richard barograph; (3) Casella self-recording rain-gauge; (4) Beckley anemograph; (5) sunshine recorder.

Besides the above instruments there are in use at the observatory three maximum solar radiation thermometers, one ordinary sun thermometer (not self-registering), and one grass radiation thermometer.

A large number of special temperature readings was taken from thermometers in the shed and Stevenson screens to find the difference between the two forms of exposure. Also a number of wet bulb readings was made with different arrangements of the wet threads to find the effect of excessive or defective water-supply on the wet bulb temperatures.

Character of the work of observation at Second and Third Class Observatories.

18. The general character of the work of the observatories judged by the number of mistakes made by observers does not appear so satisfactory this year as during the previous year. The number of stations of great reliability in which either no mistake or only one has been detected in the data for the Indian Daily Weather Report was only 14 as against 22 last year, while the number of stations at which more than 50 mistakes were made increased from 6 to 24.

This large increase in mistakes was not due to unsatisfactory observing but to a change in the method of counting mistakes. In previous years it had been the custom not to count an observation wrong if it was wrongly telegraphed, but correct in the E register; during the year a change was made by which all observations which were wrongly telegraphed whether right or wrong in the E register were counted as mistakes; that the observations themselves were satisfactory is shown by the fact that at only five stations were more than fifty mistakes made in the observations.

The usual list showing the number of observations rejected, and also the number of telegrams incorrectly prepared, for all the observatories which send weather telegrams to the Simla office, was prepared and circulated to the observatories at the end of the year under review.

Inspection of Observatories.

19. The number of visits paid to observatories during the year was 72 as compared with 85 in the previous year and an average of 78 during the past eight years.

The Director-General inspected the observatories at Calcutta, Bombay, Madras and Kodaikanal. Mr. Patterson inspected thirteen stations mainly in northwest India. Dr. Simpson inspected eleven stations in Burma and one on the east coast of India. Mr. Bion inspected two, Mr. Gaetane twenty-four, Lala Hem Raj four, Ganesh Sadashiv three and C. C. Mudaliar eight.

One observatory was inspected twice so that the actual number visited was 71: of these 43 were reported as good, 18 as tolerable and 10 as bad.

The corresponding numbers last year were 68, 6 and 5.

Condition.	Number of observatories inspected in						
	1907-1908.	1906-1907.	1905-1906.	1904-1905.	1903-1904.	1902-1903.	1901-1902.
Good or satisfactory ...	43	68	48	58	45	55	61
Tolerable	18	6	13	13	22	21	12
Bad	10	5	4	5	2	10	9
Total ...	71	79	65	76	69	86	82

20. It is desirable that there should be more frequent inspection of observatories, especially those established in connection with hospitals, dispensaries and post offices, on account of the changes of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments.

Special Observations.

21. Observations other than those recorded at regular intervals are made as follows :—

(*a*) In response to requests from the Simla or Calcutta office when weather is disturbed and storm warnings may have to be issued: such observations are always sent by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Re. 1 for each set of special observations sent at the request of either Simla or Calcutta. The number of telegrams of the latter class forwarded during this year was 933 as compared with 817 last year.

(*b*) Certain observers have been empowered, when they consider that conditions at sea are sufficiently threatening, to send of their own initiative to Simla or Calcutta a telegram containing special observations. No occasion of this type occurred.

(*c*) In connection with flood warning a number of observers have been instructed to send telegrams announcing the occurrence of heavy rainfall to Government officers and railway engineers who desire early information. The number of telegrams so sent was 49 as compared with 87 last year.

(*d*) After earthquakes, observers are instructed to send information in as definite a form as is possible: 4 reports were sent during the year.

Observations with Special Meteorological Instruments.

22. The following special observations were carried out during the past year at certain selected stations :—

1st.—Wind observations recorded by Beckley anemographs at 17 stations and by Dines pressure tube anemometers at five stations.

2nd.—Solar and terrestrial radiation observations at twelve stations.

3rd.—Underground temperature observations at 3 stations.

4th.—Sunshine observations at 10 stations.

5th.—Barometric observations recorded by self-registering instruments, chiefly Richard barographs, at 41 stations.

6th.—At the beginning of the year 37 thermographs were in use, but during the year 20 of these were withdrawn as it was considered that sufficient data had

been obtained from these instruments. Two instruments were out of order during the greater part of the year.

Observations of Solar energy in absolute units.

23. Observations were taken at Simla throughout the year when weather conditions allowed, by means of Angstrom's Electric Pyrheliometer.

Work with baloons and Kites.

24. Work with balloons and kites was actively continued. Kites carrying instruments were flown in July and August at Belgaum, where heights of about $2\frac{1}{2}$ miles above sea level were reached, and in August and September over the Bay of Bengal and Arabian Sea, where kites rose to nearly 2 miles above the ship. The instrumental records of temperature and humidity were under preparation for press at the end of the year.

Observation baloons of gutta percha tissue were liberated from Simla as in previous years, but with certain improvements in detail, and their courses and velocities were traced by theodolites.

Considerable advances were made in the development of light recording apparatus for balloon work over the plains of India and of very light balloons to carry them; and experiments were conducted in Lahore in February as a preliminary step to work in the Punjab further to the west, where some series of high ascents were then being arranged for. This balloon work differs from that which has for some years been carried on in Simla, in that the information required from it is given by instruments carried by the baloon itself, and is thus only obtainable in cases where the instruments can be retrieved. The method is an important one, and had been kept in view for India for some years, but as a large proportion of the balloons and instruments would never be recovered after descending it was not possible to adopt it until a sufficiently cheap instrument had been devised and arrangements made for its manufacture.

Seismograph Observations.

25. Seismological observations were recorded by means of Milne's self-registering seismographs during the year, as in previous years, at Alipore (Calcutta), Kodaikanal and Colaba (Bombay), and by means of other self-registering instruments at the last named station. All the instruments worked satisfactorily throughout the year, and copies of the records of the Milne's seismographs were regularly transmitted to the Seismological Committee of the British Association.

At Simla also there is a seismograph, of Omori-Ewing pattern; this has been in use throughout the year and records of the severe earthquakes which have occurred throughout the world during the year have been obtained with it.

Atmospheric Electricity.

26. During the greater part of the year a nearly continuous record was obtained in Simla of the electrical potential gradient in the atmosphere by means of a Benndorf self-registering electrometer. Arrangements were made for an investigation into the electrical condition of rain and a small hut was prepared to house the apparatus; but the monsoon came to an end before the apparatus was ready, and the actual observations had to be postponed until the following rains.

Marine Meteorology.

27. No significant change was made during the year under review in the collection of marine information.

At Calcutta and Bombay a clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard for the purpose of applying the necessary corrections to the readings of the logs; and after the barometer

comparisons have been tabulated in the Calcutta or Bombay office a statement of the error of the ship's barometer is posted to the captain in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port but it is ample for our purposes.

The data thus obtained are utilised in the preparation of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department; and for drawing up an account of the storms of the year for publication in the Annual Summary.

28. The arrangements made with the London Meteorological Office, the Royal Alfred Observatory Mauritius, the Weather Bureau Washington, and the Deutsche Seewarte Hamburg, for collecting marine data from the whole of the Indian Ocean (see last year's report) has been continued and the thanks of this department are again due to these four offices for supplying such a large amount of useful data.

29. The issue of pilot charts giving, month by month, the normal meteorological conditions over the Indian seas and the Indian Ocean as far south as Lat. 12° S., was continued. These charts show the mean pressure, the mean direction and force of the wind, the mean surface currents and the ordinary tracks of storms in the month under review, together with a brief synopsis of the normal conditions of the month. The chart for each month was issued about the 15th of the month preceding the period to which it referred. The charge for each copy was four annas as before. The total monthly issue amounted to about 200 copies.

As stated last year it had been decided to alter the method of publication of these charts and instead of issuing them month by month, with annual repetition, to publish a small atlas containing the twelve monthly charts of normal conditions and such additional charts of special conditions as might be thought desirable in order to make the atlas as useful as possible. The calculation of the necessary data and the preparation of the charts had been completed during the year 1905-06 and the results were sent to Messrs. Bartholomew of Edinburgh, for publication.

Owing to the preparation of the atlas taking longer than was expected publication did not take place during the year under review, but final proofs had been corrected and returned before the end of March.

30. Observations recorded during the year at the entrance to the River Hooghly were supplied to the Meteorological Department by the Light Vessels Cornet, Torch, Hesperus and Luna and by the dredger Sandpiper.

Snowfall Registration in the Mountain Districts to the North and West of India.

31. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas for the cold weather of 1907-08 was on the whole tolerably complete and the thanks of the Department are again due to the various officers who have collected and forwarded it. The difficulty has again been felt that while the reports provided may represent faithfully the impressions of subordinate officers, they cannot be relied upon for that accurate comparison of one year with another which is desirable in the interest of climatic study. Important and reliable additions to the information have been obtained by continuing the series of large-scale photographs of the snows as seen from Simla which had been started in 1905.

Rainfall Registration.

32. No change was made in the system of rainfall registration during the year under review. A full account of the methods employed, which came into full operation during the year 1891-92, will be found in pages 5—3 of the Administration Report of the year 1889-90, or in pages 6, 7 of the Administration Report of the year 1890-91.

33. The following is a classified statement of the total number of rain-gauge stations at the end of the year in the various political divisions of the empire, and

of the number of rain-gauge stations of which inspection reports were received by the Indian Meteorological Office during the year 1907-08 :—

Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1908.	Number of inspections of rain-gauges in 1906-07 of which copies of the reports were received in the Simla Meteorological Office.				Percentage of inspections of which copies of reports were received to total number of rain-gauges.
		Good.	Fair.	Bad.	Total.	
Eastern Bengal and Assam ...	232	42	8	...	50	23
Baluchistan	61	...	...	...	...	...
Bengal	312	58	18	1	77	31
Bombay and Sind	289	...	...	...	...	...
Burma	185	25	4	2	31	17
Central India	115	...	...	...	...	...
Central Provinces and Berar ...	170	48	10	...	58	31
Hyderabad	22	...	...	...	...	...
Kashmir	37	...	...	...	...	...
Madras (including Pudukkottai, Coorg, Travancore and Cochin).	497	232	148	8	388	74
Mysore	77	...	...	...	...	...
North-West Frontier Province ...	34	1	...	...	1	...
Punjab	189	58	16	4	78	27
Rajputana	179	24	2	1	27	12
United Provinces of Agra and Oudh ...	278	17	3	...	20	10
Total ...	2,677	505	209	16	730	...

Note.—In several cases the same gauge was inspected more than once during the year.

34. The registration of rainfall in India has invariably been carried out by the provincial authorities and in the larger provinces under the general control of the Boards of Revenue. Previous to 1889 the hours and arrangements for the registration of rainfall differed largely in different provinces. In 1889 a uniform system was introduced by the Government of India, and the Director General of Observatories was made consulting officer in connection with this work. The local officers superintend the registration of rainfall and submit brief annual administrative reports to their respective Governments, copies of which should be forwarded to the head of this department.

The following paragraphs give a brief summary of the reports of rainfall registration for the year 1906-07 submitted to the various Local Governments and Administrations by these local officers.

35. *Baluchistan.*—No report was received.

36. *Bengal.*—During the year new rain-gauge stations were started at Pachet, Amlagara, Poorya, Sonakhalla, Jenkia and Tanghi, and six stations were closed. The total number of rain-gauges in use on the 31st March 1908 was 312. Sixty-four were inspected in the course of the year.

37. *Bombay and Sind.*—"The total number of rain-gauge stations in the Presidency including Sind which reported rainfall to this office was 336 as against 337 in the previous year—one station (Talegaon Dabhoda in the Poona District) having been discontinued."

"Out of a total of 275 gauges in the British Districts, 195 or about 71 per cent. as against 216 or about 78 per cent., last year, came under inspection

64 of these were inspected more than once and the total number of inspections amounted to 280 as against 347 in the previous year. Sufficient attention did not appear to have been paid to this piece of work in 4 districts in the Deccan, 2 districts in Gujarat, and one district each in Karnatak, Konkan and Sind. The attention of the Collectors concerned is being invited to it. "

" Inspection in the Native States showed a little improvement over last year, 37 out of a total of 61 rain-gauges, or merely 61 per cent. as against 59 per cent., last year, having come under inspection this year; 5 gauges were inspected more than once, the total number of inspections amounting to 43, same as last year."

38. *Burma.*—" The total number of rain-recording stations in the Province is 185 against 183 at the close of the preceding year, of which 14 are Meteorological Observatories and 22 are under the charge of the Public Works Department.

" Three new stations were opened during the year, namely:—Cheduba in the Kyaukpyu District, Pyu in the Toungoo District, and Ngazun in the Sagaing District. All these are under the charge of the Civil Department. The Nattalin station in the Tharrawaddy District was closed in April 1907, as there was no one in the station capable of making accurate records of the rainfall.

" The total number of rain-gauges inspected during the year was 147, of which 133 are reported in good condition, 9 in a fair state and 5 bad. The rainfall is reported to be properly registered in all the stations inspected except in Hmawbi (Hanthawaddy District) where it was found that the rain-gauge was buried beneath a wagon load of stones. It has therefore been decided to discontinue the registrations of rainfall temporarily, but the Agricultural Department has consented to arrange for accurate observations when a resident staff is appointed for the Hmawbi Agricultural farm. The position of 106 stations is reported as good, 28 as fair and 13 as bad. The main defects are faulty position owing to the close proximity to the gauges of buildings or trees or unevenness of the mouth of the funnel and where possible steps have been taken to remedy these. The Deputy Commissioner, Tavoy, has arranged to remove the tree adjoining the gauge in the Yebyu in his District and the Deputy Commissioner, Prome, contemplates shifting the gauge at Prome to a new site.

" During the year one complete rain-gauge was supplied to the Deputy Commissioner, Kyaukpyu, for use in the newly-opened rainfall registration station, Cheduba. In addition to this seven measuring glasses, three receivers, three funnels, three spirit levels and 2 cylinders were supplied to other stations in the Province to replace old and unserviceable ones.

" The returns sent to this office were on the whole received punctually except in the case of some stations where delays are unavoidable owing chiefly to difficulties of communication. "

39. *Central India.*—No report has been received.

40. *Central Provinces and Berar.*—"The number of rain-gauges maintained in the Central Provinces * was 105 as in the previous year. Of this number 9 are observatories under the control of the Meteorological Department and of the 96 remaining 23 are managed by the Medical Department, 15 are maintained by Feudatory States and 58 are either in charge of kanungos, police muharrirs or schoolmasters. The total number of inspections made of the rain-recording stations in the Central Provinces aggregated 130 against 132 in the preceding year and 121 in the year 1905-06.

" The number of rain-gauges in Berar during the year remained unaltered, namely 44. Of this number 4 are observatories under the control of the Meteorological Department and of the remainder 37 are managed by civil surgeons and hospital assistants and 3 by tahsildars. No rain-gauge station was established or abolished during the year, and the situation of the rain-gauges remained the same.

The number of inspections made of the rain-gauge stations during the year was 115 against 124 in the previous year."

* Other than those under the Irrigation Department.

41. *Eastern Bengal and Assam.*—The total number of stations on the 31st March 1908 was 232, 110 in the Eastern Bengal and 122 in the Assam districts, as compared with 107 and 122, respectively in the previous year. Three new stations were opened during the year under report in the Dacca district. 121 different rain-gauges were inspected during the year.

42. *Hyderabad.*—No report was received.

43. *Kashmir.*—No report was received.

44. *Madras.*—" On the 31st March 1907 there were 465 rain-recording stations, excluding the meteorological observatories, furnishing rainfall returns for publication in the Fort St. George Gazette. To these six more were added and one was closed during the year, so that on 31st March 1908 there were 470 Revenue Board rain stations and 26 meteorological observatories furnishing rainfall returns. Of this total 391 are in the Madras Presidency and 344 or 88 per cent., were inspected during the year., In January 1908 a list of rain-gauge stations not inspected or reported on since 1st April 1907 was sent to the Collectors and the Assistant Commissioners of Salt, Abkari and Customs Department, with a request that, if possible, these stations should be inspected before the end of the official year. All the stations in the Godavari, Nellore, Chingleput, South Canara, South Arcot, Salem, Cuddapah and Kurnool districts were inspected, and the inspection list in the other districts was almost equally satisfactory except in Ganjam, North Arcot, Malabar and Anantapur, where only about half the number of the stations were visited. Thirty-seven indents for rain-gauges, glass measures, etc., were received and submitted to the Imperial Meteorological Office for compliance : while village rain-gauge funnels and measuring cans were made under the supervision of this Office at Madras and supplied to the Collectors of Kistna, Salem and Tinnevelly."

45. *Mysore.*—The number of Rain-gauge stations in the state subject to inspection was 212 at the close of December 1907, as against 209 of the previous year, there being an increase of three. The total number of gauges inspected during the calendar year 1907 was 161 or 75·9 per cent. of the total number; there was thus a falling off of about 9 per cent. from the inspection record for 1906.

46. *North-West Frontier Province.*—No report has been received.

47. *Punjab.*—" There are 40 rain-gauges under the Canal Department, and 149 looked after by district officers. The latter have increased by one, a new gauge having been established at Bari in the Rohtak District. The canal stations have tube gauges and also in some cases self-registering Watson's gauges : the latter seem to give some trouble. The civil gauges are all of Symon's pattern.

The gauges are generally in good order and suitably placed. No post cards recording inspection have been received from thirteen district officers and the attention of the Deputy Commissioner is being invited to the necessity of inspections. The Revenue Assistant of each district should inspect the gauges but they saw only 13 gauges in the whole year. My assistant and I inspect the gauge at all tahsils which we visit. "

48. *Rajputana.*—No report was received.

49. *United Provinces of Agra and Oudh.*—" There are now 289 rain-reporting stations in these provinces, including the meteorological observatories, all of which use gauges of the Symons pattern.

" Out of the 276 stations under district and canal officers' supervision, 116 or nearly 42 per cent., were reported as inspected during the year under review. This is a falling off of 43 inspections or 16 per cent. since last year. In 11 districts all the gauges were inspected, in 16 districts one station only in each was inspected and in 13 districts no inspections were made.

" I regret to have to call attention to the serious falling off in the number of inspections, and would call special attention to the lack of inspection in the Lucknow district in which no station has been reported as inspected during the past three years. "

50. *Summary.*—The work of rainfall registration is still being carried on in a satisfactory manner ; there has been however during the last year a slight falling off in the number of gauges inspected in some districts but other districts show a gratifying improvement in this respect.

Storm Warnings.

51. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed by two officers. Ports on the Bay of Bengal are warned from the Calcutta office by the Meteorologist, Calcutta, and ports on the Arabian Sea from the Simla Office by the Director General of Observatories or by one of his assistants.

The complete system at present in operation includes :—

1st.—An extended system of storm signals for use at the larger and more important ports.

2nd.—A brief system of storm signals for use at the smaller ports, chiefly for the information of native vessels and local traffic.

52. *Bay of Bengal Storm Signal Service.*—The following is a list of the ports for the warning of which during the year 1907-08 the Meteorologist, Calcutta, was responsible :—

Port Blair.	Akyab.	Chandbali.	Cocanada.
Mergui.	Chittagong.	False Point.	Masulipatam.
Tavoy.	Narayanganj.	Puri.	Madras.
Moulmein.	Barisal.	Gopalpur.	Cuddalore.
Rangoon.	Calcutta and River Hooghly.	Calingapatam.	Negapatam.
Bassein.	Balasore.	Vizagapatam.	Pamban.

Tuticorin. | Colombo.

Telegraphic information is also sent to Chittagong, Narayanganj and the Orissa ports whenever storm signals are hoisted at Saugor Island.

It may be noted that in the case of the Bengal ports and Port Blair the signals are hoisted by the direct orders of the Meteorologist, Calcutta. In the case of the Burma and Coromandel coast ports, the storm signals are hoisted by the orders of the Port Officers, acting on information respecting the path and intensity of the storms received at short intervals during their progress from the Meteorologist, Calcutta.

Storm signals were hoisted on nine occasions and various ports were warned by cautionary signals on eight occasions during the storm season. The weather was disturbed by depressions on fourteen occasions but only once did the depression develop into a severe storm, while none developed into a cyclone.

53. There are also special arrangements at Calcutta for supplying daily to Saugor Island and to certain ports in the Bay information as to the state of the weather in the Bay at 8 A. M. for the benefit of shipping. This information is given partly by a system of flag signal messages indicating generally the state of the weather in four sections of the Bay and partly by means of a special code telegram in which the information is of a more detailed character.

The daily flag signal message, according to the recent arrangements sanctioned by the Government of India, was sent to Saugor Island throughout the year and to Elephant Point from 1st April 1907 to 14th January 1908 only. This message was also sent to the Port Officer, Rangoon, during the period 15th January to 31st March.

The following officers were supplied with the flag signals and the daily weather telegram from 1st April 1907 to 14th January 1908 :—

Port Officer, Rangoon.	Port Officer, Cuddalore.
Secretary, Port Commissioners, Rangoon.	Ditto, Negapatam.
Port Officer, Cocanada.	Port Conservator, Porto Novo.

Deputy Port Conservator, Madras.

The following officers received the daily weather telegram only during the period from 1st April 1907 to 14th January 1908 :—

Port Officer, Moulmein.
Ditto, Akyab.
Ditto, Gopalpur.
Ditto, Vizagapatam.

The Port Officer, Chittagong, received the daily weather telegram and the flag signal message from 16th May to 15th November.

The telegram was also sent to the Port Conservator, Calingapatam, on Sundays, Wednesdays, and Thursdays.

The following officers were added to the list of officers receiving warning telegrams during bad weather or cyclonic storms on the Madras coast :—

Executive Engineer,	Godavari Eastern Division, Dewlaishweram.
Ditto,	Godavari Western Division at Chettipet *via* Nidadavol.
Ditto,	Godavery Conservancy Division, Rajahmundry.
Ditto,	Kistna Eastern Division, Bezwada.
Ditto,	Nellore Division, Nellore.
Ditto,	Cauvery Division, Tanjore.
Collector of	Godavari, Cocanada.
Ditto,	Kistna, Masulipatam.
Ditto,	Guntur, Guntur.
Ditto,	Nellore, Nellore.
Ditto,	Tanjore, Tanjore.
Ditto,	Trichinopoly, Trichinopoly.

54. *Arabian Sea Storm Signal Service.*—The work of warning the Arabian Sea ports was carried out during the past year by the Simla Meteorological Office which also warned the Madras ports on the Malabar coast in the same manner as the Meteorologist, Calcutta, warned the Madras ports on the coast of the Bay of Bengal. Warnings of storms in the Arabian Sea were also sent to the Port Officer, Aden, for the information of steamers leaving that port for Colombo, Bombay and Kurrachee. Copies of all warnings sent to the Malabar ports were forwarded for information to the Master Attendant, Colombo; the Commercial Agent to the Diwan of Alleppi; the Presidency Port Officer, Madras; the Deputy Port Conservator, Madras; and the Chief Engineer for Irrigation, Madras.

Warnings were also sent to the Dewan of Junagadh, the Sub-divisional Officer, Sacrifice Rock Lighthouse, Badagara, and, indirectly through the Commander of the Port, Mormugao, to the Portuguese port of Din.

The following is a list of the Bombay and Malabar ports for the warning of which during the year 1907-08 the Simla Metecrological Office was responsible :—

I.—By extended system.	II.—By Brief system.	
Kurrachee.	Cutch-Mandvi.	Murud-Janjira.
Bombay.	Jamnagar.	Ratnagiri.
Mormugao.	Dwarka.	Harnai.
Mangalore.	Porbandar.	Malwan.
Tellicherry.	Veraval.	Goa.
Calicut.	Jafrabad.	Vengurla.
Cochin.	Bhavnagar.	Karwar.
	Daman.	Kumta.
	Alibag.	Honavar.

55. In 1907-08 there were four periods of bad weather in the Arabian Sea for which warnings were issued, the most important disturbance being a storm of

considerable intensity which formed off the Kathiawar coast on the 3rd June 1907. Signals were hoisted at all ports from Kurrachee to Bombay, Danger Signal No. 3 (intimating that the storm would cross the coast at or near to the port) being displayed at Kurrachee from the early morning of the 5th. The storm centre actually crossed the coast at Kurrachee at 12-30 on the 6th and did considerable damage; but the greater part of the shipping was saved owing to precautions taken on receipt of the warnings. A prolonged period of unsettled weather lasting from the 11th to the 18th June followed the disappearance of this storm, and was itself succeeded by another storm which appeared off the Sind coast on the 20th and crossed that coast next day to the east of Kurrachee. Warnings were sent to all ports from Kurrachee to Colombo during the period of disturbed weather but for the storm that followed warnings were not necessary for any ports south of Bombay.

On the 5th November 1907 an area of disturbed weather from the Bay of Bengal passed westwards over Ceylon into the south of the Arabian Sea, and apparently developed into a cyclonic storm, which probably moved northwestwards, ceasing to effect the Indian Seas by the 10th. Warnings were issued to all ports from Colombo to Kurrachee.

In addition to the above disturbances in the Arabian Sea a depression of the winter type passing through Baluchistan from Persia in February 1908 occasioned strong winds on the Mekran coast, and Kurrachee was informed on the 17th of the conditions prevailing there.

Seasonal Forecasts.

56. The forecast for the monsoon period of 1907, dated the 8th June, was sent to Local Governments and Administrations, communicated to the Press and printed in the Gazette. A statement of the rainfall of June and July with a forecast for August and September was drawn up on the 8th August and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was drawn up on the 10th December 1907 and sent to Local Governments and Administrations.

As the result of the comparison of the monsoon forecasts it appeared that the effect of the heavy snowfall in producing delay in the establishment of the monsoon and diminished total rainfall in north-west India was rightly interpreted in June, as also was the disappearance of this influence in August; and the unsteadiness of the general conditions was recognized. But of the most important feature of the monsoon, its failure in September, there was no intimation; and the anticipation in the June forecast that the total rainfall of India during the period June to September was likely to be up to the normal, was not verified.

57. A memorandum on the weather during October and November, 1907, with a forecast of the rainfall in northern India and of the snowfall on the neighbouring mountain areas during the cold weather of 1907-08, was prepared on the 6th December and issued in the same manner as the forecast of the previous June. The inferences given in the memorandum were:

"It appears from the records of the past thirty years that conditions like those of the present season have been followed by a deficiency of precipitation in January definitely, but not very conspicuously, more often than by an excess. The rainfall and snowfall during the earlier portion of the approaching cold weather are therefore somewhat more likely to be below than above the average, but it does not appear that a definite forecast of a deficiency would be justified.

The evidence now available does not afford any indications with regard to the precipitation of February."

On the 8th July 1908 a comparison of the actual rainfall with the above forecast was issued, it stated:

"The actual data show that during December there was a strong defect, and in January an excess. The total rainfall during these two months, the

earlier portion of the cold weather season, proved to be in defect by about 16 per cent., while in February, for which month no forecast was made, rainfall was also in marked defect. For the cold weather period, December to February, the total precipitation proved to be decidedly below normal."

FLOOD WARNINGS AND WEATHER FORECASTS TO DISTRICT OFFICERS, IRRIGATION AND OTHER OFFICERS OF THE PUBLIC WORKS DEPARTMENT AND TO EXPEDITIONS IN THE FIELD.

58. This work is carried out chiefly by the Simla Meteorological Office but partly by that of Calcutta. The arrangements for it have been sanctioned at various times, and differ considerably in character, depending upon the nature and extent of the flood or weather warnings required by the officers concerned. In some cases these officers require telegrams warning them of advancing storms likely to give heavy rain; in other cases they require telegrams giving information of actual heavy rainfall in the hill districts, likely to give rise to severe floods which might injure the railways or canal works in the submontane districts under their charge; and in others they require warnings or forecasts of the weather for as long a period beforehand as possible, so as to enable them to modify their arrangements for carrying on the works under their charge so far as may be necessitated by sudden or large changes of weather.

59. Warnings of heavy rain likely to give rise to floods in the Nerbudda and Tapti rivers are sent to nine officers in the Presidency of Bombay (Bombay City, Gujarat and Khandesh). The telegrams which are sent by the Simla Office warn these officers of the existence of storms likely to give heavy rain, and the meteorological observers of Hoshangabad, Jubbulpore, Khandwa, Pachmarhi, Amraoti, Akola and Chikalda telegraph directly to the same officers the actual amount of the rainfall whenever it exceeds three inches in twenty-four hours.

60. Arrangements have been in force for some time whereby telegrams recording heavy rain in the Punjab and neighbouring districts are sent to certain selected officers of the North-Western Railway to warn them of the probability of floods on different parts of the line. In order to save the time occupied by the transmission of the weather messages to Simla and the re-transmission of their contents to the railway officials concerned, it has been arranged that whenever there is a fall of 2″ of rain in 24 hours at Simla, Chakrata, Sialkot, Murree, Peshawar, Cherat, Srinagar or Gulmarg, information of the occurrence shall be telegraphed direct by the meteorological observers at those stations to the railway officials concerned.

61. In 1906 arrangements were made whereby the Executive Engineer, northern drainage and embankment division, Calcutta, should receive notice direct from the meteorological observers in Chota Nagpur of the occurrence of rain amounting to 3″ or more in 24 hours. This warning system was extended in 1907-08 to include the sub-divisional officer in charge of the canal at Edilpore and the Executive Engineer, Jajpur Division, Cuttack and, except in the case of the last-named officer, the Simla Office now sends warnings whenever there is a probability of heavy rainfall affecting the areas concerned.

62. During the year the Engineer-in-Chief of the Nagda-Muttra railway asked for warnings against heavy rain in the catchment area of the Chambal River. It was arranged that the Simla Office should warn him whenever there was a likelihood of heavy rain, and that the meteorological observers at Indore and Neemuch should telegraph to him whenever there was an occurrence of over two inches of rainfall in twenty-four hours.

63. The number of district officers and officers in the Irrigation, Railway and Public Works Departments requiring warnings from Simla amounted at the end of the year to 86.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Kurrachee, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

The number of special warning messages sent during the year 1907-08, was 1,149, as compared with 990 in 1906-07 and 554 in the year before.

64. Warnings of floods or of heavy rainfall were issued by the meteorologist, Calcutta, to 27 officers of the Public Works, Telegraphs and other Departments, chiefly in Bengal and on the east coast.

65. Instructions were issued eight years ago by the Government of India that every officer to whom storm or flood warnings are issued, should in the month of January of each year, or in the case of military expeditions at the close of the campaign, forward to the head of this department a brief return of the warnings received during the past year and should also report:—

(1) Whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

(3) Whether the warnings were timely and satisfactory in every respect and, if not, in what points they were defective.

(3) Whether any changes might be made in the system which would make the warnings more useful.

Reports on the storm and flood warnings for the year 1907 were received from fifty officers. Of these thirty-three reported that the warnings were timely and satisfactory and were rapidly transmitted by the Telegraph Department.

Fifteen offered no remarks and two officers reported that they had received no warnings during the year. No suggestions were made for improving the usefulness of the Flood Warning Service.

Transmission of messages from the Andaman Islands by wireless telegraphy.

66. Arrangements were made in 1905 for the transmission by wireless telegraphy of the 8 h. observations from Port Blair and Slipper Island and of special observations in the case of unsettled conditions in the Bay of Bengal.

The service worked in a most satisfactory manner during practically the whole of the year 1907-08, with the exception of a period of 24 days in June and July, and the information that it conveyed again proved of the greatest value in connection with the daily weather reports of Simla, Calcutta and Madras, as well as in the more important work of warning for storms in the Bay.

Daily weather telegraphic summary.

67. Changes were made last year by which it became possible to despatch the daily telegraphic summary at noon and these have worked satisfactorily; it was very seldom during the year that the despatch was delayed for more than a few minutes.

The summary is now posted at certain telegraph offices, is sent to 79 servants of Government, to 7 subscribing newspapers and to 12 private subscribers.

Publications.

A.—Weather Reports.

68. *India Weather Reports.*—The following weather reports, giving information of the current weather to the Government and the public, were published during the year by the Simla Meteorological Office:—

(1) India Daily Weather Report.

(2) India Weekly Weather Report, giving an account of the weather and of the rainfall of the week ending on the previous Thursday, published in the *Gazette of India* every Saturday.

(3) Monthly supplement to the India Daily Weather Report.

(4) Annual supplement to the Daily Weather Report.

(5) India Monthly Weather Review, giving a general summary of all the important features of the weather and complete meteorological data of the month.

(6) Annual Summary of the Monthly Weather Reviews.

It was stated in last year's administration report that an attempt was being made to arrange the divisions for which meteorological data are calculated and published in the several publications of the Simla Office in some simple way in order to facilitate their application to Administrative, Commercial and Agricultural ends.

A decision as to the most suitable method was arrived at after consultation with other departments interested in climatic data and the sanction of the Government of India was given to the proposed changes.

The system of treating data which is now in operation in the department is to arrange those received from meteorological stations according to the following main and sub-divisions :—

Main Divisions.	Sub-Divisions.
	Bay Islands.
Burma	Lower Burma.
	Upper Burma.
Eastern Bengal and Assam	Assam.
	Eastern Bengal.
Bengal...	Bengal.
	Orissa.
	Chota Nagpur.
	Bihar.
United Provinces	United Provinces, East.
	Do. do. West.
Punjab	Punjab, East and North.
	Punjab, South-West.
North-West Frontier Province ...	North-West Frontier Province.
Sind	Sind.
Rajputana	Rajputana, West.
	Rajputana, East.
Bombay	Gujarat.
	Konkan.
	Bombay Deccan.
Central India	Central India, West.
	Do. do., East.
	Berar.
Central Provinces	Central Provinces, West.
	Central Provinces, East.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

Main Divisions.	Sub-Divisions.
Hyderabad	Hyderabad, North. Do. South.
Mysore	Mysore.
Madras	Malabar. Madras, Southeast. Do. Deccan. Do. Coast, North.

The three areas, Bay Islands, Kashmir and Baluchistan, not included in any main division, are classed with the above sub-divisions.

These divisions having been accepted as meteorological units are used in all departmental reports and tables of meteorological statistics. The new arrangement greatly reduced the work of tabulation in the department, for while previously nearly every report issued by the department differed as to the areas to which the data referred and so necessitated the preparation of separate tables in each case, it became possible to arrange the data according to the new divisions once for all and use the results so obtained in each of the separate discussions.

69. *India Daily Weather Report.*—The number of stations for which data were given in the daily report of the 31st of March 1907 was 173, and in that of the 31st March 1908, 175. The report was issued on March 31st, 1908, to 529 recipients or 18 more than on the same date of the previous year.

On the 1st October 1907, the new divisions as described in para. 69 were brought into use, and the map on page 4 of the report was changed to show the new divisional boundaries.

70. *India Weekly Weather Report.*—The Weekly Weather Report was published in the *Gazette of India* as in previous years. During the cold weather this report and tabular statement were, as usual at that time of year, telegraphed from Simla to Calcutta in time for publication in the *Gazette.*

On the 3rd of October the divisions used in this Report were changed to those mentioned in paragraph 69 above.

Up to the report of the 10th October it had been usual to give in these reports the rainfall in hundredths of an inch, but in that and subsequent issues the rainfall amounts were given to the nearest tenth.

71. *Monthly Supplement to the India Daily Weather Report.*—This supplement was introduced in July 1906 in order to afford as soon as possible after the end of each month a short account of the weather of the month and a tabular statement of temperature, cloud, humidity and rainfall.

For this purpose it is not necessary to have the complete reports from all stations under the department for conclusions, correct in general, can be drawn from the data used in the Daily Weather Reports. As the fuller data do not have to be awaited, it is possible to issue this short general monthly report within a few days of the end of the month ; and about twelve weeks before the larger complete Monthly Weather Review can be produced.

72. *Annual Supplement to the India Daily Weather Report.*—This supplement was published for the first time in January 1908 and gave a short summary of the chief meteorological features of the year 1907.

73. *India Monthly Weather Review.*—Considerable changes were made in the Monthly Weather Review. The data were classified on the new basis already

described and the divisions in the Monthly Weather Review were thus brought into line with those used in the Daily Weather Report. The matter of the Review is now presented in the following order :—

Introduction.

Summary of the chief features of the weather in India during the month.

Solar, seismic and magnetic disturbances.

Weather in the Indian monsoon region.

Depressions and cyclonic storms.

Pressure.

Temperature.

Winds.

Humidity and cloud.

Rainfall.

Snowfall.

Crop report.

Table A.—Abstract of observations taken at 10 hrs. and 16 hrs. at 38 stations in India, etc.

Table B.—Abstract of observations taken at 8 hrs. at 235 stations in India, etc.

(1) Provincial means.

(2) Data of stations.

Table C.—Abstract of observations taken at 8 hrs., at 25 fourth class stations in India, etc.

Plate I.—India Weather Chart shewing the monthly mean of 8 hrs. distribution of pressure, wind direction and wind velocity.

Plate II.—India Weather Chart shewing the departure from normal of the monthly mean of 8 hrs. pressure.

Plate III.—Two charts shewing the departure from normal of the monthly mean of daily (*a*) maximum (*b*) minimum temperature respectively.

Plate IV.—Two charts (*a*) shewing the departure from normal of the monthly mean of daily mean temperature ; (*b*) shewing the monthly mean of pressure and resultant wind direction.

Plate V.—Two charts (*a*) shewing the departure from normal of the monthly mean of absolute humidity at 8 hrs. ; (*b*) shewing the departure from normal of the monthly mean of relative humidity at 8 hrs.

Plate VI.—Two charts (*a*) shewing the departure from normal of the monthly mean of cloud amounts at 8 hrs. ; (*b*) shewing the total number of days in the month on which rainfall equalled or exceeded 0·10 inch.

Plate VII.—India Weather Chart shewing normal monthly rainfall and the departure from normal of the actual monthly rainfall.

It will be seen from the above in comparison with an old Monthly Weather Review that Tables I and II of the latter became respectively Tables B and A of the former and that a new table, Table C, was added to contain the data of all observatories that did not record barometric pressure. The changes in the plates were the re-arrangement of the divisions according to the new scheme and the omission of the chart shewing the monthly distribution of rainfall. This chart was based on the rainfall returns of the meteorological observatories alone, while the second rainfall chart, Plate VIII of the previous reviews which has now become Plate VII, is based on the fuller data from the many rainfall stations under the

various Local Governments, and so gives much more reliable information. There appeared to be no reason for continuing to publish two rainfall charts, and for the above reasons the latter was preferred. Owing to the postponement of the publication of the Monthly Weather Review from January 1907, until a decision had been reached with regard to the proposed changes, and as the changes when decided on necessitated the preparation of new engraved plates the reviews were very late in appearing, and at the end of March 1908 they had only been published up to March 1907.

74. *Annual Summaries.*—The annual summary of the meteorology of India for 1906 supplementing the Monthly Weather Reviews for that year, was issued in April 1908. It contains mean data for the year and a discussion of its more important meteorological features together with their relations to each other. A summary of the meteorology of the year 1906 was prepared for the Sanitary Commissioner with the Government of India, and was given as Chapter I of the Annual Report of that officer for the year 1906.

75. *Special Charts.*—The Simla office prepared, throughout the year, weekly charts showing the character of the rainfall of each week and of the seasonal rainfall up to date, for the use of His Excellency the Viceroy, His Majesty's Under-Secretary of State for India, London, and the Secretary to the Government of India in the Revenue and Agricultural Department. Similar charts were also forwarded to the Lieutenant-General Commanding the Forces in Bengal, Naini Tal.

The Calcutta office of the India Meteorological Department prepared four series of seasonal rainfall charts and annual rainfall charts of the whole of India, as in previous years, for the information of the Government of India and the Secretary of State.

76. *Provincial Weather Reports.*—The following provincial reports were issued by the local meteorologists during the year :—

(1) By the Meteorologist, Calcutta—

(*a*) Bay of Bengal and Bengal Daily Weather Report. The name of this report was changed on the 1st January 1908 to "Calcutta Daily Weather Report."

(*b*) Meteorological Table for Bengal and Assam, with a summary of the chief features of the weather for the month published regularly in the *Calcutta Gazette.*

(*c*) The supplementary weekly meteorological and rainfall table containing temperature and rainfall observations recorded at 19 stations in Bengal and in Eastern Bengal and Assam was issued to all subscribers of the Calcutta Weather Report on every Wednesday throughout the year. For purposes of comparison, temperature and rainfall observations recorded during the corresponding week of 1907 were added to the report.

---

(2) By the Meteorologist, Bombay—

(*a*) Bombay Daily Weather Report.

During the year under review the Director General of Observatories, the Director of Agriculture, the Meteorologist, Bombay, and the Secretary of the Bombay Chamber of Commerce held a conference to consider possible improvements in the Bombay Daily Weather Report to make it of more general use to those interested in climatic conditions. As a result of the conference the following changes were introduced into the report :—

(i) The size of the printed report was reduced.

(ii) The printed matter was re-arranged on the four sides of the report as follows :—

Page (*1*).—Contains a summary put into the form of a paragraphs to describe the weather features of each division.

Page (2).—Contains a map which occupies the whole page.

Page (3).—Contains the 8 h. observations.

Page (4).—Contains the bi-weekly rainfall reports and the telegraphic weather and crop reports.

(iii) Daily telegrams from six new stations were included; these were Multan, Rawalpindi, Ambala, Mainpuri, Chandra and Nizamabad (Indur).

(iv) A new map was prepared in order to include the new stations.

(v) Arrangements were made by which twelve extra stations were to send bi-weekly telegram of rainfall only.

These changes were carried out on the following dates:—

(v) Partly on 27th August 1907.

(ii) and (iii) on 2nd September 1907.

(i) and (iv) on 1st January 1908.

(*b*) Monthly, abstracts of meteorological observations published in the Bombay Government *Gazette.*

---

(3) By the Meteorologist, Madras—

(*a*) Madras Daily Weather Report.

(*b*) Monthly rainfall tables for Madras, Coorg, Pudukkottai, Cochin and Travancore published in the Provincial *Gazette.*

---

(4) By the Meteorologist, Allahabad—

(*a*) Monthly weather Summary of the province published in the Provincial *Gazette.*

(*b*) Brief sketch of the meteorology of the province for the year 1906.

(*c*) Monthly Rainfall Tables for the United Provinces of Agra and Oudh, published in the Provincial *Gazette.*

---

(5) By the Simla Office—

(*a*) Monthly summary of the weather of the Punjab, published in the Provincial *Gazette.*

(*b*) Annual meteorological summary of the Punjab for the year 1906-07.

B.—MEMOIRS OF THE INDIAN METEOROLOGICAL DEPARTMENT.

77. The following was published during the year 1906-07:—

(1) A discussion of the anemographic observations recorded at Allahabad from September 1890 to August 1904, and a discussion of the anemographic observations recorded at Lucknow from July 1878 to October 1892, by Sir John Eliot, M.A., F.R.S., K.C.I.E., late Meteorological Reporter to the Government of India and Director-General of Indian Observatories. (Memoirs of the Indian Meteorological Department, Vol. XVIII, Part III.)

78. The following were under preparation during the year:—

(1) Kite flights made at Belgaun during premonsoon and monsoon periods in 1906, by J. H. Field, M.A., Imperial Meteorologist.

(2) A discussion of some of the anemographic observations recorded at Madras. By R. Ll. Jones, M.A., Meteorologist, Madras.

(3) Types of Weather in Madras. By R. Ll. Jones, M.A., Meteorologist, Madras.

(4) Kite flights in India and over the neighbouring sea areas during 1907. By J. H. Field, M.A., Imperial Meteorologist.

(5) Correlation in seasonal variation of climate. By G. T. Walker, M.A., Sc.D., F.R.S., Director-General of Observatories.

The lithographic reproduction of the more important seismograms given by the Simla seismograph since 1905 for publication as a Memoir was also undertaken during the year.

C.—Other Publications.

79. The following was published during the year 1907-08 :—

Appendix to the Handbook of Observatories. A collection of facts for departmental reference.

80. The following were under preparation during the year 1907-08:—

(*a*) A Meteorological Atlas of the Indian Seas and the North Indian Ocean, prepared chiefly by Mr. W. L. Dallas and to be published by Messrs. Bartholomew.

(*b*) Telegraphic Code and instructions for the use of the Indian Meteorological Department during stormy and suspicious weather (2nd edition).

(*c*) Tables for the reduction of meteorological observations.

Supply of Meteorological Information.

81. In addition to the meteorological information published by the department, special information was supplied to other meteorological institutions either by letter or telegram according to arrangements made.

(*a*) Weekly telegrams containing weekly pressure departures from normal of Bombay, Seychelles, Zanzibar and Aden were sent to the Director-General, Survey Department, Cairo, during the monsoon period.

(*b*) Monthly telegrams were sent to the Meteorological Office, London, during the monsoon period to inform him of the state of the monsoon.

(*c*) Monthly telegrams were sent to Sir Norman Lockyer, London, throughout the year giving 8 A.M. mean monthly pressure of Bombay reduced to S. L. and 45° latitude.

(*d*) Monthly telegrams were sent to the Meteorological Department, Sydney, Australia, throughout the year giving monthly mean pressure and temperature departures from normal of India, represented by the stations Lahore, Allahabad, Calcutta, Nagpur, Bombay, Madras and Bangalore, and a short description of the general condition of weather over India.

(*e*) Weekly code telegrams were sent during the monsoon period to the Calcutta Meteorological Office for drawing up a table of rainfall, humidity and temperature at 100 representative stations in India to be published by the Director-General of Commercial Intelligence in the Indian Trade Journal.

Miscellaneous.

82. Two mechanics are now employed regularly in the workshop in the Simla Office, and they have been engaged mainly on developing and making instruments connected with the kite and balloon work and other branches of the researches undertaken by the officers of the Department.

83. Eleven hundred and forty-seven books and pamphlets, either purchased or presented by scientific bodies, were added to the Library during the year. The Library is on the whole in fair order.

84. Nine libraries, observatories or societies were added during the year to the list of institutions to which the publications of the India Meteorological Department are supplied, and three were removed; the number on the list is now 371.

Chief features of the year.

85. The area from which meteorological information is derived was widened during the year by the establishment of new observatories at Birjand, Kerman and Kermanshah (Persia); Kaigil (Kashmir); and Monghyr; and was further extended under an arrangement by which the Foreign Department of the Government of India kindly undertook to supply weather data for past years, and in future, from the diaries of Consulates in Persia and elsewhere.

An important change in the distribution of weather information to the public was the issue of an Annual Supplement to the Daily Weather Report. This supplement brings together in a concise form the chief points of the meteorology of the year and has the advantage that it can be published within a few weeks of the close of the calendar year.

The Meteorological Atlas of the Indian Seas and the North Indian Ocean was on the point of publication at the close of the year.

Much progress was made in the scientific work of the Department on the lines indicated in the Administration Report of the previous year, and preparations for a more extended scope of the practical side of research work were undertaken.

Concluding Remarks.

86. The Meteorological Department again received valuable assistance in its work from the Survey, Telegraph and Postal Departments during the year.

87. The Telegraph Department has continued to assist the Department by the rapid transmission of daily weather telegrams, and of storm and flood warning telegrams. There are in all 24 observatories established at Departmental Telegraph Offices, the observation being taken either by the Telegraph Master or by a signaller, and except at some stations the observations were satisfactory throughout the year.

88. By permission of the Postal Department meteorological observatories are established at eighteen combined Postal and Telegraph offices. Observations at the great majority of these stations are taken by one of the telegraph signallers, but in one or two cases by the postmasters. With certain exceptions these observatories also worked satisfactorily during the year.

89. Daily weather telegrams from Aden were sent free of charge to Bombay by the Eastern Telegraph Company during the year and the Department is greatly indebted to the Eastern Telegraph Department for this valuable concession as well as for the rapid transmission of the messages.

90. The observatories at Baghdad, Ispahan, Teheran, Meshed, Muscat, Jask and Bushire furnished valuable observations throughout the year. Daily weather telegrams were transmitted as far as Kurrachee, free of cost to the Department, from Muscat, Bushire and Jask throughout the year and from Meshed, Ispahan, Teheran and Baghdad from the beginning of November to the end of the official year. These telegrams were forwarded from Kurrachee to Simla in the same manner as Indian weather telegrams, and were very useful in forecasting the approach of cold weather storms from Persia to northern India. The Department is greatly indebted to the Directors of the Persian Gulf Section and of the Persian Section of the Indo-European telegraph line for the continuance of this valuable concession.

91. Weekly telegrams were received from the 4th May to the 26th October from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These

telegrams gave valuable information of the weather conditions in the Indian Ocean and the Department is indebted to the officers for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the India Meteorological Department.

92. The Department is greatly indebted for important information as to meteorological conditions prevailing antecedent to and during the south-west monsoon, to the Director of the Government Observatory, Durban; Mr. J. McClounie, head of the Scientific Department, Zomba, British Central Africa; the Meteorologist, Dar-es-Sallam; His Majesty's Commissioner, Entebbe, Uganda; the Director-General, Survey Department, Cairo; the Director of the Government Observatory, Perth; the Government Astronomer, Adelaide; the Government Astronomer, Sydney; the Director of the Central Nicolas Physical Observatory, St. Petersburg (for information as to Siberian conditions); the Directors of the Observatories at Buenos Ayres and Santiago; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

J. H. FIELD,

Offg. Director-General of Observatories.

METEOROLOGICAL OFFICE, SIMLA;

The 12th September 1908.

G. C. B. P., Simla.—No. 274 M. R. G. I.—29-9-08.—280.—R.G.G.

REPORT

ON

THE ADMINISTRATION

OF

THE METEOROLOGICAL DEPARTMENT

OF

THE GOVERNMENT OF INDIA

IN

1908-09.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

DEPARTMENTAL CHANGES DURING THE YEAR 1908-09.

Temporary changes in the staff.

Dr. Gilbert T. Walker, Director General of Observatories, proceeded on privilege leave for two months and three days combined with special leave for three months and thirty days with effect from the 9th April 1908, and took over charge on the 12th October 1908 from Mr. Field who officiated for him during this period.

2. Mr. J. H. Field, Imperial Meteorologist, proceeded on privilege leave for one month from the 25th November 1908 to the 24th December 1908 inclusive; his place had been taken by Mr. Bion.

3. Mr. J. Patterson, Imperial Meteorologist, proceeded on privilege leave for two months and twenty-one days combined with special leave for three months and nine days with effect from the afternoon of the 18th March 1909. Mr. Bion was appointed to officiate for him.

4. Mr. R. Ll. Jones, Meteorologist, Madras, returned to duty on the forenoon of the 7th September 1908 from furlough for fourteen months combined with summer vacations (from the 6th May 1907 until the 8th July 1907), and took over charge from Mr. R. Littlehailes.

5. Dr. E. G. Hill, Meteorologist, Allahabad, proceeded on leave from the 24th April 1908 to the 11th July 1908. Mr. U. C. Ghosh and Dr. A. P. Sircar acted during his absence.

6. Mr. C. W. Peake, M.A., Meteorologist, Calcutta, proceeded on nine months' leave with effect from the 24th March 1909. His duties were entrusted to Dr. E. P. Harrison.

7. Mr. N. U. K. Leslie, Meteorologist, Bombay, proceeded on three months' privilege leave from the 12th April 1908 and rejoined on the 13th July 1908. Mr. H. Mayston officiated during this period.

8. The period of service of Mr. C. Michie Smith, Director of the Kodaikanal and Madras Observatories, was extended in November last by a year from the 13th July 1909.

OBSERVATORIES.

9. The observatories maintained by the Government of India are classified as follows :—

First Class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, and wind direction and velocity in addition to instruments read by eye.

Second Class.—Observatories at which readings are taken daily at 8 hrs., 10 hrs. and 16 hrs.: those at 8 hrs. are (with a few exceptions) transmitted by telegram to one or more of the offices at Simla, Calcutta, Bombay and Madras for inclusion in the India or provincial Daily Weather Reports.

Third Class.— Observatories—

(*a*) where readings are taken daily at 8 hrs. only; in those stations where there are telegraph offices the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports;

(*b*) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determination of monthly and daily means which should be comparable with the means already obtained for second class observatories.

Fourth Class.—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only, are recorded.

10. At the commencement of the year 272 observatories contributed registers of meteorological data; of these 49 were non-departmental and 223 were maintained by the Government of India. At the end of the year the total number of observatories was 280, of which 50 were non-departmental and 230 were maintained by the Government of India.

Of the 230 departmental observatories, 7 were first class, 21 second class, 179 third class and 23 fourth class.

11. The changes in non-departmental observatories during the year were the following :—

(1) Fourth class observatories were opened (1) at Maidan Minaften on the 1st May 1908, under the superintendence of His Britannic Majesty's Consul, Muhammerah, Persian Gulf; (2) at Turbat-i-Haidari on the 1st August 1908, under the superintendence of His Britannic Majesty's Consul at Turbat-i-Haidari, Khorasan, Persia; and (3) at Ahwaz on the 1st October 1908, under the superintendence of the Political Resident, Persian Gulf, Bushire.

(2) The 4th class observatory at Tura in Assam was closed in May 1908.

(3) The 3rd class observatory at Dunga (Zanzibar) was closed in October 1908.

(4) The 2nd class observatory at Jamnagar was changed to 3rd class in March 1909.

12. The following were the changes in departmental observatories during the year :—

(1) Third class observatories were opened at Cox's Bazar, Kyaukpyu, the pilot vessel "Lady Fraser", and Gartok on the 15th April 1908, 28th April 1908, 3rd July 1908 and 1st November 1908, respectively.

(2) Fourth class observatories were opened at Chumbi and Yatung in May 1908, at Chhindwara on the 1st June 1908, and at Koweit on the 1st August 1908.

(3) The 2nd class observatory at Karachi was changed to 3rd class after 30th June 1908, and the observatory was transferred to Manora on the 4th July 1908.

First Class Observatories.

13. The Directors of the Government Observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded through the Department for the information of Government. It has accordingly been ruled that it is unnecessary to include information relating to the working of these observatories in the present Administration Report.

14. *The Alipore Observatory.*—This observatory is under the charge of the Meteorologist, Calcutta. It is furnished with a complete set of autographic instruments, including a Whipple-Casella sunshine recorder, a Bergholz barograph, a Kew barograph, a Kew thermograph, a Richard thermograph, a Beckley anemograph, a Dines pressure-tube anemometer, a Beckley rain-gauge, a Michie Smith monthly rain-gauge, and a Milne horizontal pendulum seismograph.

These instruments have on the whole worked satisfactorily during the past year.

15. All instruments issued by the Meteorological Department are tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 486 as compared with 503 last year. Forty instruments were condemned as unfit for issue, or were repaired by the Mathematical Instrument Department or the departmental mechanic, and five instruments were kept in store for future treatment.

16. The observatory gives mean Calcutta time to the port and shipping. Three time balls are dropped daily at 1 P.M. local mean time throughout the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioner's office and the third at the Kidderpore Docks.

This work was carried out satisfactorily on the whole. There were 18 failures as compared with the average number 11·5 of the past twenty years; in all cases they were due to faulty behaviour of the electric or mechanical arrangements outside the observatory.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1908-1909	18	18
1907-1908	10	10
1906-1907	25	24
1905-1906	11	11
1904-1905	3	3
1903-1904	20	20
1902-1903	14	14
1901-1902	13	13
1900-1901	15	15
1899-1900	13	13
1898-1899	6	6
Mean of ten years, 1888-98	10	10

17. *The Allahabad Observatory.*—This observatory is under the charge of the Meteorologist, Allahabad. The self-recording instruments in use at the observatory were :—(1) a Beckley anemograph; (2) a Richard barograph; (3) a Richard thermograph (giving both wet and dry bulb records); and (4) a Stokes sunshine recorder.

There were also in use at the observatory (1) three solar radiation thermometers; (2) a grass thermometer for measuring terrestrial radiation; (3) one ground thermometer placed on the surface; (4) the ordinary complement of instruments for eye observations of atmospheric pressure, temperature, vapour pressure, humidity, cloud, wind and rainfall; (5) six barometers for purposes of comparison and for use in the inspection of observatories; (6) a Marie Davy and a Duboscq nephoscope; (7) and a full set of ordinary thermometers in a second cage for purposes of comparison.

18. *Beckley anemograph.*—The instrument worked well throughout the year, except on five occasions when short breaks occurred in the trace.

Dines pressure anemometer.—The two pressure tube anemometers have been temporarily removed to the Muir College for experimental purposes.

Richard barograph.—This instrument gave excellent tracings throughout the year. All the charts have been tabulated.

Richard thermograph.—The wet bulb tracings of the thermograph have not been very satisfactory, but the dry bulb tracings, with a few exceptions, have been good.

Sunshine recorder.—This gave good results without a break.

Nephoscope.—Regular observations of clouds have been made with the Duboscq instruments.

Readings of all the eye instruments were taken every two hours, from 6 hrs. to 22 hrs. The earth thermometer on the surface was read at 6, 14 and 22 hrs.

19. *The Lahore Observatory.*—Eye observations of the ordinary meteorological instruments were taken seven times daily at this observatory as in past years, at 6, 8, 10, 14, 16, 18 and 22 hrs. Ground surface temperature was recorded four times daily, at 6, 10, 16 and 22 hrs.

The observatory is furnished with the following automatic instruments which have worked satisfactorily during the year :—

(1) Draper barograph; (2) Richard barograph; (3) Casella self-recording rain-gauge; (4) Beckley anemograph; (5) sunshine recorder.

Besides the above instruments there are in use at the observatory three maximum solar radiation thermometers, one ordinary sun thermometer (not self-registering), one grass radiation thermometer, and one nephoscope.

Character of the work of observation at Second and Third Class Observatories.

20. The general character of the work of the observatories, as judged by the number of mistakes made by observers, appears to have been satisfactory. The number of stations of great reliability in which either no mistake or only one has been detected in the data for the Indian Daily Weather Report was 9 as against 14 last year, but on the other hand the number of stations at which more than 50 mistakes were made decreased from 24 to 19.

The usual list showing the number of observations rejected, and also the number of telegrams incorrectly prepared, for all the observatories which send weather telegrams to the Simla office, was prepared and circulated to the observatories at the end of the year under review.

Inspection of Observatories.

21. The number of visits paid to observatories during the year was 65 as compared with 72 in the previous year and an average of 77 during the past nine years.

The Director General inspected the observatories at Calcutta, Bombay, Madras, Kodaikanal and six observatories in Burma. Mr. Patterson inspected sixteen stations mainly in the central parts of the country. Dr. Simpson inspected eleven stations in Eastern Bengal and Assam. Mr. Bion inspected one, Mr. Gaetane twenty-two, Ganesh Sadashiv four and Babu Joti Lal De one.

Three observatories were inspected twice so that the actual number visited was 62 ; of these 40 were reported as good, 20 as tolerable and 2 as bad.

Condition.	Number of observatories inspected in					
	1908-09.	1907-08.	1906-07.	1905-06.	1904-05.	1903-04.
Good or satisfactory	40	43	68	48	58	45
Tolerable	20	18	6	13	13	22
Bad	2	10	5	4	5	2
Total .	62	71	79	65	76	69

22. In estimating the general character of the observatories from the above table it must be remembered that it is, as a rule, on account of something unsatisfactory that a visit of inspection is made. The general level of the stations is thus decidedly better than might otherwise appear. The most frequent cause of bad work is the changing of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments.

Special Observations.

23. Observations other than those recorded at regular intervals are made as follows :—

(*a*) In response to requests from the Simla or Calcutta office when weather is disturbed and storm warnings may have to be issued: such observations are always sent by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Re. 1 for each set of special observation sent at the request of either Simla or Calcutta. The number of telegrams of the latter class forwarded during this year was 797 as compared with 933 last year.

(*b*) Certain observers have been empowered, when they consider that conditions at sea are sufficiently threatening, to send of their own initiative to Simla or Calcutta a telegram containing special observations. No occasion of this type occurred.

(*c*) In connection with flood warning a number of observers have been instructed to send telegrams announcing the occurrence of heavy rainfall to Government officers and railway engineers who desire early information. The number of telegrams so sent was 62 as compared with 49 last year.

(*d*) After earthquakes observers are instructed to send detailed information to the Simla office: 60 reports were received during the year.

Observations with Special Meteorological Instruments.

24. The following special observations were carried out during the past year at certain selected stations :—

1st.—Wind observations recorded by Beckley anemographs at 17 stations and by Dines pressure tube anemometers at five stations.

2nd.—Solar and terrestrial radiation observations at twelve stations.

3rd.—Underground temperature observations at three stations.

4th.—Sunshine observations at ten stations.

5th.—Barometric observations recorded by self-registering instruments, chiefly Richard barographs, at thirty-nine stations.

6th.—Temperature observations recorded by self-registering instruments, chiefly Richard thermographs, at twenty stations.

Observations of solar energy in absolute units.

25. Observations were continued at Simla and Kodaikanal throughout the year when weather conditions allowed, by means of Angstrom's Electric Pyrheliometer. These were however discontinued at Simla from October 16th to November 10th, during the removal of the office to new quarters.

Work with balloons and kites.

26. It has been found in Europe and America that the temperature of the air diminishes with altitude up to a height of about six miles and that temperature then remains practically stationary up to the greatest height attained, about seventeen miles. It was accordingly considered desirable to make ascents up to at least 50,000 feet with the object of ascertaining whether these conditions prevailed over India and preliminary experiments with recording instruments and balloons of special design were carried out early in 1908. Twenty-three instruments were sent up, seven in June and sixteen in September and October, from Jhang in the Punjab. Two-thirds of these instruments were recovered, as a consequence of extensive advertisement by vernacular papers among the villages of the districts where the descent of the instruments was expected to take place. The records were in most cases in good condition on recovery, and show that the region of constant temperature is met in India at heights of between nine and ten miles, the temperature there ranging between 100° and 120° Fahr. below freezing point.

Seismograph observations.

27. Seismological observations were recorded by means of Milne's self-registering seismographs during the year, as in previous years, at Alipore (Calcutta), Kodaikanal and Colaba (Bombay), and by means of other self-registering instruments at the last named station. All the instruments worked satisfactorily throughout the year, and copies of the records of the Milne's seismographs were regularly transmitted to the seismological committee of the British Association.

In Simla the Omori-Ewing seismograph was kept in use throughout the year except for the short period during which the observatory was being shifted to new quarters. A second seismograph of the same type but of an improved pattern and of larger size was put into action on November 10th, the direction of its boom being north-south, while that of the smaller seismograph was east-west.

Both instruments remained in effective use in their new positions to the end of the year. They are now housed in a more convenient and suitable manner than formerly, and the standard clock with electric minute and hour contacts is placed in the seismograph building.

Atmospheric Electricity.

28. The Benndorf self-registering electrometer was maintained in good order throughout the year and gave a continuous record of the potential gradient

except for a short period during which the instrument was being removed to the new office.

The investigation of the electrical condition of rain was carried on by means of apparatus specially designed for the work. Laboratory experiments bearing on the same subject were also undertaken and the results of the whole were presented to the Royal Society, London, in February 1909.

MARINE METEOROLOGY.

29. No change was made during the year under review in the method of collecting marine information.

At Calcutta and Bombay a clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard for the purpose of applying the necessary corrections to the readings of the logs; and after the barometer comparisons have been tabulated in the Calcutta or Bombay office a statement of the error of the ship's barometer is posted to the captain in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port but it is ample for our purposes.

The data thus obtained are utilised in the preparation of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department, and for drawing up an account of the storms of the year for publication in the Annual Summary.

30. The arrangements made with the London Meteorological Office, the Royal Alfred Observatory at Mauritius, the Weather Bureau, Washington, and the Deutsche Seewarte, Hamburg, for collecting marine data from the whole of the Indian Ocean has been continued and the thanks of this department are again due to these four offices for supplying such a large amount of useful data.

31. The issue of pilot charts giving, month by month, the normal meteorological conditions over the Indian seas and the Indian Ocean as far south as Lat. 12° S. was discontinued. The charts have been replaced by "The Meteorological Atlas of the Indian Seas" published for the department by Messrs. Bartholomew of Edinburgh. The atlas contains (*a*) twelve charts showing the normal pressure, wind direction and force, and sea currents for each month, (*b*) nine charts showing monthly storm tracks in the Arabian Sea and Bay of Bengal between 1893 and 1903, (*c*) ten charts illustrating typical storms at different seasons of the year in the Arabian Sea, and (*d*) five charts illustrating typical storms at different seasons of the year in the Bay of Bengal. In addition to the charts the atlas also contains directions for using the pressure data given on the charts, and a list of the storm signals used at Indian ports.

32. Observations recorded during the year at the entrance to the River Hooghly were supplied to the Meteorological Department by the light-vessels "Comet" and "Luna."

SNOWFALL REGISTRATION IN THE MOUNTAIN DISTRICTS TO THE NORTH AND WEST OF INDIA.

33. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete and the thanks of the Department are again due to the various officers who have collected and forwarded it. The difficulty has again been felt that while the reports provided may represent faithfully the impressions of subordinate officers, they cannot be relied upon for that accurate comparison of one year with another which is desirable in the interest of climatic study. Reliable additions to the information have been obtained by continuing, though from a lower altitude, the series of large-scale photographs of the snows as seen from Simla which had been started in 1905.

RAINFALL REGISTRATION.

34. The registration of rainfall in India has invariably been carried out by the provincial authorities and in the larger provinces under the general control of the Boards of Revenue. In 1889 a uniform system was introduced by the Government of India, and the Director General of Observatories was made consulting officer in connection with this work. The local officers superintend the registration of rainfall and submit brief annual administrative reports to their respective Governments, copies of which should be forwarded to the head of this Department. A full account of the methods employed, which came into full operation during the year 1891-92, will be found in pages 5—8 of the Administration Report of the year 1889-90, or in pages 6, 7 of the Administration Report of the year 1890-91.

35. The following is a classified statement of the total number of rain-gauge stations at the end of the year in the various political divisions, and of the number of rain-gauge stations of which inspection reports were received by the Indian Meteorological Office during the year 1908-09 :—

PROVINCE OR DIVISION.	Number of rain-gauges supplying returns for publication on 31st March 1909.	NUMBER OF INSPECTIONS OF RAIN-GAUGES IN 1908-09 OF WHICH COPIES OF THE REPORTS WERE RECEIVED IN THE SIMLA METEOROLOGICAL OFFICE.				Percentage of inspections of which copies of reports were received to total number of rain-gauges.
		Good.	Fair.	Bad.	Total.	
Eastern Bengal and Assam	235	30	6	2	38	16
Baluchistan	59	...	...	...	...	...
Bengal	322	48	9	2	59	18
Bombay and Sind	289	...	...	...	...	...
Burma	190	26	6	1	33	17
Central India	121	...	...	...	...	...
Central Provinces and Berar	171	44	10	...	54	32
Hyderabad	22	...	...	...	...	...
Kashmir	37	...	...	...	...	...
Madras (including Pudukkottai, Coorg, Travancore and Cochin).	503	250	133	11	394	78
Mysore	77	...	...	...	...	...
North-West Frontier Province	34	...	1	...	1	3
Punjab	189	55	21	5	81	43
Rajputana	180	15	0	...	15	8
United Provinces of Agra and Oudh	277	21	6	...	27	10
TOTAL	2,706	489	192	21	702	26

NOTE.—In several cases the same gauge was inspected more than once during the year.

The following paragraphs give a brief summary of the reports of rainfall registration for the year 1908-09 submitted to the various Local Governments and Administrations by the local officers.

36. *Baluchistan.*—No report was received.

37. *Bengal.*—During the year additional returns were submitted from ten new rain-gauge stations, of which five are in the Midnapore district. The total number of rain-gauges in use on the 31st March 1909 was 322. Eighty-five were inspected in the course of the year.

38. *Bombay and Sind.*—"The total number of rain-gauge stations in the Presidency including Sind which reported rainfall to this office was 336, the same as in the previous year."

"Out of a total of 275 gauges in the British Districts, 183 or about 66 per cent. as against 195 or about 71 per cent. last year came under inspection; 74 of these were inspected more than once and the total number of inspections amounted to 289 as against 280 in the previous year. Sufficient attention was not paid to this piece of work in four districts in the Deccan, two each in Karnatak and Konkan, one in Gujarat and four in Sind. The attention of the Collectors concerned is being invited to it."

"Inspection in the Native States showed an improvement over last year, 42 out of a total of 61 rain-gauges, or nearly 69 per cent. as against 61 per cent. last year, having come under inspection this year; 5 gauges were inspected more than once, the total number of inspections amounting to 49."

39. *Burma.*—"The total number of rain-recording stations in the Province is 190 against 185 at the close of the preceding year. Of these 14 are Meteorological Observatories and 25 are under the charge of the Public Works Department.

"Three new stations were opened during the year, namely:—Yawnghwe in the Southern Shan States and Pwinbyu and Shawktaw in the Minbu District. All these are under the charge of the Public Works Department. Observations were taken at the former station from the 1st October 1908 and at the two latter stations from February 1909. Though the stations at Bôkpyin, Tenasserim and Palaw were opened during 1906-1907, it was not till May 1908 that records were taken at Bôkpyin and Tenasserim and in June 1908 at Palaw. The Hmawbi station in the Hanthawaddy district was closed from the 1st April 1908, owing to the want of a reliable person to look after the gauge and to take readings. This station will be re-opened when the Agricultural Department commences work at the Agricultural Station there.

"During the year sanction was recorded by the Local Government to the opening of Provincial Observatories at Kēngtūng and Loimwe in the Southern Shan States, and by the Commissioner of Settlements and Land Records to the establishment of rain-recording stations at Yedashe in the Toungoo District, Kyauktaw in the Akyab District, and Kalewa, Masein and Kelemyo in the Upper Chindwin District, but observations have not yet been taken at any of these places.

"The total number of rain-gauges inspected during the year was 140, of which 129 are reported in good condition, 10 in a fair state and one bad. The position of 110 stations is reported as good and 30 as fair. The main defects are faulty position, owing to the close proximity to the gauges of buildings or trees or unevenness of the mouth of the funnel. Where possible steps have been taken to remedy these defects. The station at Wetpyuye in the Southern Shan States was closed during June 1908, and the rain-gauge transferred to Kalaw where observations have been taken since the 1st July. The gauge at Pyinnyaung in the Méiktila district was removed to a better site.

"The subject of Rainfall which has hitherto been dealt with by the Commissioner of Settlements and Land Records was transferred to the Director of Agriculture in November 1908. The return sent to this office have on the whole been received punctually except in the case of some stations where delays are unavoidable owing chiefly to difficulties of communication."

40. *Central India.*—No report has been received.

41. *Central Provinces and Berar.*—"The number of rain-gauges maintained in the Central Provinces* was 105 as in the previous year. Of this number 11 are observatories under the control of the Meteorological Department, and of the 94 remaining 26 are managed by the Medical Department, 15 are maintained by Feudatory States and 53 are either in charge of kanungos, police muharrirs or schoolmasters. The total number of inspections made of the rain-recording stations in the Central Provinces aggregated 148 against 130 in the preceding year and 132 the year 1906-07.

* Other than 22 under the Irrigation Department.

"The number of rain-gauges in Berar during the year remained unaltered, namely 44. Of this number 4 are observatories under the control of the Meteorological Department and of the remainder 37 are managed by civil surgeons and hospital assistants and 3 by tahsildars. No rain-gauge station was established or abolished during the year, and the situation of the rain-gauges remained the same. The number of inspections made of the rain-gauge stations during the year was 129 against 115 in the previous year."

42. *Eastern Bengal and Assam.*—The total number of stations on the 31st March 1909 was 236, 112 in the Eastern Bengal and 124 in the Assam districts, as compared with 110 and 122, respectively, in the previous year. Four new stations were opened during the year under report, two in Faridpur and two in Sylhet. The number of different rain-gauges inspected during the year was 121.

43. *Hyderabad.*—No report was received.

44. *Kashmir.*—No report was received.

45. *Madras.*—"On the 31st March 1908 there were 470 rain-recording stations, excluding the meteorological observatories, furnishing rainfall returns for publication in the Fort St. George Gazette. To these six more were added during the year, so that on 31st March 1909 there were 476 Revenue Board rain stations and 26 meteorological observatories furnishing rainfall returns. Of this total 392 are in the Madras Presidency and 352 or 90 per cent. were inspected during the year."

46. *Mysore.*—"During the calendar year 1908 four new stations were added to the list making in all 216 stations at the close of the year."

"There was some improvement in the number of gauges inspected during the year 1908—the total being 180 out of 216 or 83·3 per cent. as against 75·9 per cent. the previous year."

47. *North-West Frontier Province.*—No report has been received.

48. *Punjab.*—"The total number of rain-gauge stations in the Punjab is 190 or one more than last year. Of these 149 are in charge of the district officers and 41 are under the Canal Department. The latter department located two new gauges, at Chichoki Mallian and Mangatanwala, in the 4th Division of the Upper Chenab Canal, but closed their gauge at Gujranwala, where there is one under the civil authorities. A rain-gauge at Amritsar was removed from the premises of the Jail to a position in the District Court compound where it could be properly supervised by the Sadr Kanungo.

"There were 109 inspections by different Revenue Officers during the year as against 71 made last year. My personal assistants and I inspected 39 gauges. No post card inspection reports were received from the Settlement Officer, Karnal, and the Deputy Commissioners of Simla, Amritsar, Gurdaspur, Gujrat, Jhelum and Lyallpur. Only 13 Revenue Assistants out of 29 made 24 inspections during the year. The attention of the Deputy Commissioners is being invited again to the importance of regular inspections.

"The reports received from the officers of the Canal Department show that the rain-gauges under their charge have been regularly inspected from time to time and have been maintained in good order, except most of the self-registering Watson's gauges which continued to give trouble.

"All the rain-gauges under the District Officers are reported to be in good order and the rainfall records are properly and neatly kept. The falls have been duly registered and the rules are properly understood by the officials in charge of the gauges. The rain-gauge at the Telegraph Office at Rawalpindi is being removed from there and a new one set up in the Tahsil compound in the charge of the ordinary establishment."

49. *Rajputana.*—No report was received.

50. *United Provinces of Agra and Oudh.*—There are now 288 rain-reporting stations in these provinces, including the meteorological observatories, all of which use gauges of the Symons pattern.

Out of the 274 stations under district and canal officers' supervision, 159 or nearly 58 per cent. were reported as inspected during the year under review.

In 7 districts all the gauges were inspected, in 7 districts one station only in each was inspected and in 4 districts no inspections were made.

51. *Summary.*—The work of rainfall registration is being carried on in a satisfactory manner; there has been during the last year a slight falling off in the number of gauges inspected in some districts, but others show a gratifying improvement in this respect.

Storm Warnings.

52. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed by two officers. Ports on the Bay of Bengal are warned from the Calcutta Office by the Meteorologist, Calcutta, and ports on the Arabian Sea from the Simla Office by the Director General of Observatories or by one of his assistants.

The complete system at present in operation includes :—

1st.—An extended system of storm signals for use at the larger and more important ports.

2nd.—A brief system of storm signals for use at the smaller ports, chiefly for the information of native vessels and local traffic.

53. *Bay of Bengal Storm Signal Service.*—The following is a list of the ports for the warning of which during the year 1907-08 the Meteorologist, Calcutta, was responsible :—

Port Blair.	Akyab.	Chandbali.	Cocanada.
Mergui.	Chittagong.	False Point.	Masulipatam.
Tavoy.	Narayanganj.	Puri.	Madras.
Moulmein.	Barisal.	Gopalpur.	Cuddalore.
Rangoon.	Calcutta and River Hooghly.	Calingapatam.	Negapatam.
Bassein.	Balasore.	Vizagapatam.	Pamban.

Tuticorin. | Colombo.

Telegraphic information is also sent to Chittagong, Narayanganj and the Orissa ports whenever storm signals are hoisted at Saugor Island.

It may be noted that in the case of the Bengal ports and Port Blair the signals are hoisted by the direct orders of the Meteorologist, Calcutta. In the case of the Burma and Coromandel coast ports, the storm signals are hoisted by the orders of the Port Officers, acting on information respecting the path and intensity of the storms received at short intervals during their progress from the Meteorologist, Calcutta.

Storm signals were hoisted on seven occasions and in addition various ports were warned by cautionary signals on eleven occasions during the storm season. The weather was disturbed by depressions on twenty-one occasions, and six times the depression developed into a cyclonic storm.

54. There are also special arrangements at Calcutta for supplying daily to Saugor Island and to certain ports in the Bay information as to the state of the weather in the Bay at 8 A.M. for the benefit of shipping. This information is given partly by a system of flag signal messages indicating generally the state of the weather in four sections of the Bay, and partly by means of a special code telegram in which the information is of a more detailed character.

The daily flag signal message, according to the arrangements sanctioned by the Government of India, was sent to Saugor Island throughout the year and to Elephant Point from the 1st April 1908 to the 14th January 1909 only. This message was also sent to the Port Officer, Rangoon, during the period 15th January to 31st March.

The following officers were supplied with the flag signals and the daily weather telegram from the 1st April 1908 to the 14th January 1909 :—

Port Officer, Rangoon.	Port Officer, Cuddalore.
Secretary, Port Commissioners, Rangoon.	Ditto, Negapatam.
Port Officer, Cocanada.	Port Conservator, Porto Novo.

Deputy Port Conservator, Madras.

The following officers received the daily weather telegram only during the period from the 1st April 1908 to the 14th January 1909 :—

Port Officer, Moulmein.
Ditto, Akyab.
Ditto, Gopalpur.
Ditto, Vizagapatam.

The Port Officer, Chittagong, received the daily weather telegram and the flag signal message from the 16th May to the 15th November.

The telegram was also sent to the Port Conservator, Calingapatam, on Sundays, Wednesdays, and Thursdays.

The following officers were added to the list of officers receiving warning telegrams during bad weather or cyclonic storms on the Madras coast :—

Superintending Engineer, First Circle, Vizagapatam.

Executive Engineer, Tinnevelly Division, Palamcottah.

Executive Engineer, Madura Division.

Arrangements were made in 1905 for the transmission by wireless telegraphy of the 8 hrs. observations from Port Blair and Slipper Island, and of special observations in the case of unsettled conditions in the Bay of Bengal. The service worked in a most satisfactory manner during practically the whole of the year 1908-09, and the information that it conveyed again proved of the greatest value in connection with the daily weather reports of Simla, Calcutta and Madras, as well as in the more important work of warning for storms in the Bay.

55. *Arabian Sea Storm Signal Service.*—The work of warning the Arabian Sea ports was carried out during the past year by the Simla Meteorological Office which also warned the Madras ports on the Malabar coast in the same manner as the Meteorologist, Calcutta, warned the Madras ports on the coast of the Bay of Bengal. Warnings of storms in the Arabian Sea were also sent to the Port Officer, Aden, for the information of steamers leaving that port for Colombo, Bombay and Karachi. Copies of all warnings sent to the Malabar ports were forwarded for information to the Master Attendant, Colombo; the Commercial Agent to the Diwan of Alleppi; the Presidency Port Officer, Madras; the Deputy Port Conservator, Madras; and the Chief Engineer for Irrigation, Madras.

Warnings were also sent to the Dewan of Junagadh, the Superintendent of Telegraphs, Gujarat Division, the Sub-divisional Officer, Sacrifice Rock Lighthouse, Badagara, and indirectly through the Commander of the Port, Mormugao, to the Portuguese Port of Diu.

The following is a list of the Bombay and Malabar ports for the warning of which during the year 1908-09 the Simla Meteorological Office was responsible :—

I.—By extended system.	II.—By brief system.	
Karachi.	Cutch-Mandvi.	Murud-Janjira.
Bombay.	Jamnagar.	Ratnagiri.
Mormugao.	Dwarka.	Harnai.
Mangalore.	Porbandar.	Mulwan.
Tellicherry.	Veraval.	Goa.

I.—By extended system.	II.—By brief system.	
Calicut.	Jafrabad.	Vengurla.
Cochin.	Bhavnagar.	Karwar.
	Daman.	Kumta.
	Alibag.	Honavar.

56. In 1908-09 there were five periods of disturbed weather in the Arabian Sea for which warnings were issued, but only two were of any importance. The first was a storm which appeared off the Malabar coast in the last week of October and travelled in a north-westerly direction finally disappearing near the coast of Arabia; the Mail Steamer "Arcadia" encountered the storm on her voyage from Aden to Bombay. Warnings were issued to the Malabar and Kathiawar ports and to Colombo, Bombay, Karachi and Aden. A cyclonic storm from the Bay of Bengal passed westwards into the south-east of the Arabian Sea on the 2nd January and apparently filled up in the vicinity of Minicoy. Warnings were issued to Colombo and the Malabar ports.

57. In addition to the above, Karachi, Bombay and the Kathiawar ports were warned in August of a depression over Gujarat which, as it appeared, might perhaps pass into the Arabian Sea. In January and February Karachi was warned on three occasions of strong winds and rough seas at the entrance to the Persian Gulf.

Flood warnings and weather forecasts to District Officers, Irrigation and other Officers of the Public Works Department and to Expeditions in the Field.

58. This work is carried out chiefly by the Simla Meteorological Office, but partly by that of Calcutta. The arrangements for it have been sanctioned at various times, and differ considerably in character, depending upon the nature and extent of the flood or weather warnings required by the officers concerned. In some cases these officers require telegrams warning them of advancing storms likely to give heavy rain, in other cases they require telegrams giving information of actual heavy rainfall in the hill districts, likely to give rise to severe floods which might injure the railways or canal works in the submontane districts; and in others they require warnings or forecasts of the weather for as long a period beforehand as possible, so as to enable them to modify their arrangements for carrying on the works under their charge so far as may be necessitated by sudden or large changes of weather.

59. The number of district officers and officers in the Irrigation, Railway and Public Works Departments requiring warnings from Simla amounted at the end of the year to 88, an increase of 2 during the year.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Karachi, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

The number of special warning messages sent from Simla during the year 1908-09, was 1,199 as compared with 1,149 in 1907-08 and 990 in the year before.

Warnings of floods or of heavy rainfall were issued by the Meteorologist, Calcutta, to 36 officers of the Public Works, Telegraphs and other Departments, chiefly in Bengal and on the east coast.

Instructions were issued eight years ago by the Government of India that every officer to whom storm or flood warnings are issued, should in the month of January of each year, or in the case of military expeditions at the close of the

campaign, forward to the head of this department a brief return of the warnings received during the past year and should also report :—

(1) Whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

(2) Whether the warnings were timely and satisfactory in every respect, and, if not, in what points they were defective.

(3) Whether any changes might be made in the system which would make the warnings more useful.

Reports on the storm and flood warnings for the year 1908 were received from fifty-one officers. Of these nineteen reported that the warnings were timely and satisfactory and were rapidly transmitted by the Telegraph Department. Twenty-seven offered no remarks and five officers reported that they had received no warnings during the year. No suggestions were made for improving the usefulness of the Flood Warning Service.

The general impression given by the reports is that the system works as well as can reasonably be expected except in the forecasts of cold weather rainfall in Baluchistan. The information available for that area is inadequate, and arrangements are being made for opening two new stations.

Seasonal Forecasts.

60. The forecast for the monsoon period of 1908, dated the 9th June, was sent to Local Governments and Administrations, communicated to the press and printed in the Gazette. A statement of the rainfall of June and July with a forecast for August and September was drawn up on the 7th August and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was drawn up on the 4th December 1908 and sent to Local Governments and Administrations.

The chief points in the June forecast were (*a*) that the rains would be weak in June and perhaps during the earlier part of July, (*b*) that there were no reasons for thinking that snowfall would exercise a prejudicial influence in north-west India, and (*c*) that the total monsoon rainfall would be nearly normal or in slight defect. Of these (*a*) and (*b*) were correct and (*c*) was approximately so, the total rainfall being 6 per cent. in excess.

The August forecast anticipated a slight improvement in the general rainfall, and in particular, in the east of the United Provinces and Bihar. This was verified except in the case of Bihar where no improvement occurred.

61. A memorandum on the weather during October and November 1908, with a forecast of the rainfall in northern India and of the snowfall on the neighbouring mountain areas during the cold weather of 1908-09, was prepared on the 5th December and issued in the same manner as the forecast of the previous June. The forecast was of normal conditions.

On the 18th May 1909 a comparison of the actual precipitation with the above forecast was issued, and it was pointed out that the number of depressions had been somewhat larger than the average, though their tracks were farther north than usual: thus snowfall was in slight excess, but the rainfall in north-west India was in large defect except in Kashmir and the North-West Frontier Province.

Daily weather telegraphic summary.

62. The summary was despatched daily between 11·30 and 12.

It was posted at certain telegraph offices, sent to 86 servants of Government, to 7 subscribing newspapers and to 5 private subscribers.

Publications.

A.—Weather Reports.

63. *India Weather Reports.*—The following weather reports, giving inform-

ation of the current weather to the Government and the public, were published during the year by the Simla Meteorological Office :—

(1) India Daily Weather Report.

(2) India Weekly Weather Report, giving an account of the weather and of the rainfall of the week ending on the previous Thursday, published in the *Gazette of India* every Saturday.

(3) Monthly Supplement to the India Daily Weather Report.

(4) Annual Supplement to the Daily Weather Report.

(5) India Monthly Weather Review, giving a general summary of all the important features of the weather and complete meteorological data of the month.

(6) Annual Summary of the Monthly Weather Reviews.

For a detailed description of the contents of these publications reference may be made to the departmental Administration Report for 1907-08.

64. *India Daily Weather Report.*—The number of stations for which data were given in the daily report of the 31st of March 1909 was 175. The following table shows the distribution of the reports :—

	Number of recipients on the 31st March.							
	1909.	1908.	1907.	1906.	1905.	1904.	1903.	1902.
Government Officers . .	509	461	442	416	408	398	382	372
Foreign Recipients . .	46	45	46	45	46	46	42	40
Newspapers	2	2	2	2	2	2	2	2
Subscribers	18	20	11	14	12	13	9	13
	575	529	501	577	468	459	435	427

65. *Annual Summaries.*—The annual summary of the meteorology of India for 1907 supplementing the Monthly Weather Reviews for that year, was issued in December 1908. It contains mean data for the year and a discussion of its more important meteorological features together with their relations to each other. A summary of the meteorology of the year 1907 was also prepared for the Sanitary Commissioner with the Government of India, and was given as Chapter I of the Annual Report of that officer for the year 1907.

66. *Special Charts.*—The Simla Office prepared, throughout the year, weekly charts showing the character of the rainfall of each week and of the seasonal rainfall up to date, for the use of His Excellency the Viceroy, His Majesty's Under-Secretary of State for India, London, and the Secretary to the Government of India in the Revenue and Agricultural Department.

67. *Provincial Weather Reports.*—The following provincial reports were issued by the local meteorologists during the year :—

(1) By the Meteorologist, Calcutta—

(*a*) Calcutta Daily Weather Report.

(*b*) Meteorological Table for Bengal and Assam, with a summary of the chief features of the weather for the month, published regularly in the *Calcutta Gazette.*

(*c*) The supplementary weekly meteorological and rainfall table containing temperature and rainfall observations recorded at 19 stations in Bengal and in Eastern Bengal and Assam, issued to all subscribers of the Calcutta Weather Report on every Wednesday throughout the year.

(2) By the Meteorologist, Bombay—

(*a*) Bombay Daily Weather Report.

(*b*) Monthly abstracts of meteorological observations published in the Bombay Government *Gazette.*

(3) By the Meteorologist, Madras—

(*a*) Madras Daily Weather Report.

(*b*) Monthly Rainfall Tables for Madras, Coorg, Pudukkottai, Cochin and Travancore, published in the Provincial *Gazette.*

(4) By the Meteorologist, Allahabad—

(*a*) Monthly Weather Summary of the province published in the Provincial *Gazette.*

(*b*) Brief sketch of the meteorology of the province for the year 1907.

(*c*) Monthly Rainfall Tables for the United Provinces of Agra and Oudh, published in the Provincial *Gazette.*

(5) By the Simla Office—

(*a*) Monthly Summary of the weather of the Punjab, published in the Provincial *Gazette.*

(*b*) Annual Meteorological Summary of the Punjab for the year 1906-07.

B.—MEMOIRS OF THE INDIAN METEOROLOGICAL DEPARTMENT.

68. The following were published during the year 1908-09 :—

(1) Kite flights made at Belgaum during the pre-monsoon and monsoon periods in 1906 by J. H. Field, M.A., Imperial Meteorologist. (Memoirs of the Indian Meteorological Department, Vol. XX, Part II.)

(2) A discussion of types of Weather in Madras by R. Ll. Jones, M.A., Meteorologist, Madras. (Memoirs of the Indian Meteorological Department, Vol. XX, Part IV.)

(3) A discussion of some of the anemographic observations recorded at Madras by R. Ll. Jones, M.A., Meteorologist, Madras. (Memoirs of the Indian Meteorological Department, Vol. XX, Part V.)

(4) Correlation in seasonal variation of climate, by G. T. Walker, M.A., Sc. D., F.R.S., Director General of Observatories. (Memoirs of the Indian Meteorological Department, Vol. XX, Part VI.)

(5) Kite fligths in India and over the neighbouring sea areas during 1907, by J. H. Field M.A., Imperial Meteorologist. (Memoirs of the Indian Meteorological Department, Vol. XX, Part VII.)

C.—OTHER PUBLICATIONS.

A Meteorological Atlas of the Indian Seas and the North Indian Ocean by Mr. W. L. Dallas (see para. 31).

69. The following were under preparation during the year 1908-09 :—

(1) Telegraphic Code and instructions for the use of the Indian Meteorological Department during stormy and suspicious weather (second edition).

(2) Tables for the reduction of meteorological observations.

(3) A discussion of the anemographic observations recorded at Saugor Island from March 1880 to February 1904, and a discussion of the anemographic observations recorded at Alipore (Calcutta) from March 1877 to February 1904, by Sir John Eliot, M.A., F.R.S, K.C.I.E., late Meteorological Reporter to the Government of India and Director General of Indian Observatories. (Memoirs of the Indian Meteorological Department, Vol. XVIII, Part 2.)

(4) The Simla seismograms obtained between June 1905 and November 1908 by J. Patterson, M.A., Imperial Meteorologist. (Memoirs of the Indian Meteorological Department, Vol. XX, Part 3.)

SUPPLY OF METEOROLOGICAL INFORMATION.

70. In addition to the meteorological information published by the department the following special information was supplied to other meteorological institutions:—

(*a*) Weekly telegrams containing weekly pressure departures from normal of Bombay, Seychelles, Zanzibar and Aden were sent to the Director General, Survey Department, Cairo, during the monsoon period.

(*b*) Monthly telegrams were sent to the Meteorological Office, London, during the monsoon period to inform him of the state of the Arabian Sea and Bay of Bengal for insertion in his monthly pilot charts.

(*c*) Monthly telegrams were sent to the Solar Physics Committee, London, throughout the year giving the mean monthly pressure of Bombay.

(*d*) Monthly telegrams were sent to the Meteorological Department, Sydney, Australia, throughout the year giving the monthly mean pressure and temperature departures from normal of India, and a short description of the general condition of weather.

(*e*) Weekly code telegrams were sent during the monsoon period from Simla to the Calcutta Meteorological Office for drawing up a table of rainfall, humidity and temperature at 100 representative stations in India, to be published by the Director General of Commercial Intelligence in the *Indian Trade Journal*.

71. Climatological information, at times involving special calculation, is also provided for a number of sanitary and other officers of Government, as well as to private firms. The extent to which the Department is utilised in this manner is increasing somewhat rapidly.

MISCELLANEOUS.

72. During October and November 1908 the Simla Office was transferred from 'Constantia' to more spacious quarters at 'The Yarrows.' Two special telegraph lines had been put up and arrangements made for receiving and transmitting telegrams; thanks to the co-operation of the telegraph department the delay in the daily weather work caused by the removal has been reduced to a minimum.

73. Nine hundred and ninety books and pamphlets, either purchased or presented by scientific bodies, were added to the Library during the year. The Library is on the whole in fair order.

74. Nine libraries, observatories or societies were added during the year to the list of institutions to which the publications of the India Meteorological Department are supplied, and three were removed; the number on the list is now 377.

CHIEF FEATURES OF THE YEAR.

75. The work of the department falls naturally into two parts, the directly useful and the purely scientific which aims at ascertaining facts which shall be of practical usefulness in future. The former part consists chiefly of the collection and distribution of current weather information, the supply of climatological data, the sending of storm and flood warnings and the provision of time signals. On the other hand the scientific work includes the experimental and theoretical examination of the physical processes, alike on the earth or the sun, which determine the weather.

The publication of the meteorological atlas of the Indian seas during the past year has placed a large amount of valuable information at the convenient

disposal of ship-captains, and the opening of stations on the pilot vessel Lady Fraser, and at Cox's Bazar and Kyaukpyu have made it possible for the warning for storms in the Bay to be performed with decidedly greater efficiency. It has been found impossible in the past to secure adequate knowledge of abnormal seasons in the areas to the north and west of India, and as the amounts of winter precipitation in India and of snowfall affecting the monsoon are largely dependent on conditions in the western regions it is desirable that all the available data should be obtained. Our information will be improved by the data of the observatories opened at Gartok, Chumbi and Yatung in Tibet, Koweit in Arabia, and Ahwaz, Maidan Minuftan and Turbat-i-Haidari in Persia. Thanks also to the sympathetic assistance of the Foreign Department the current information which their political officers provide has been placed at our disposal; and we have also been given a quantity of information regarding weather in the past.

On the scientific side material advance has been made. It seemed at the outset almost vain to hope that instruments which had been carried by balloons to great heights and had descended on parachutes would be found and returned to us; but owing to the help rendered by district officers in disseminating information eleven out of the seventeen instruments sent up in September and October by Mr. Field in the Punjab have been recovered. All but one contain good records, the greatest height reached being 65,000 feet above sea-level, and the strange region of constant temperature, the existence of which it was sought to ascertain, was penetrated three times.

The investigations of the electrical conditions of rainfall undertaken by Dr. Simpson have also led to definite and important results. He has found the long-sought explanation of thunderstorms and shown that it lies in the breaking up of drops of rain carried upwards by air currents, and the consequent formation of a strong positive charge on the rain, with a negative charge in the air.

In connection with the fundamental problems connected with the sun new facts have been derived. It is obvious that since all winds are due to unequal heating of the earth's surface, any large change in the quantity of heat given out by the sun must produce important changes not only in the amount of evaporation but also of the rainfall brought by moist winds. There is reason to hope, therefore, that insight into the condition and activity of the sun may enable us to forecast its influence upon the Indian monsoon. In solar researches there have of late been rapid advances and Kodaikanal has been taking its full share in the work. The routine observations have been maintained in a high state of efficiency, and the discovery by Mr. Evershed of systematic movement of gases in the neighbourhood of a sunspot will go far to settle the vital question of what a sunspot really is.

Concluding Remarks.

76. The Meteorological Department again received valuable assistance in its work from the Medical, Telegraph and Postal Departments during the year.

77. The importance of collecting meteorological information has always been realised by medical officers in India, and many of our observatories are in hospitals with the Civil Surgeon as our Superintendent. As the work of seeing that the observer performs his duties properly is entirely unpaid, our thanks are specially due to the officers of the Medical Department.

78. The Telegraph Department has continued to assist the Department by the rapid transmission of daily weather telegrams, and of storm and flood warning telegrams. There are in all 24 observatories established at departmental telegraph offices, the observation being taken either by the telegraph master or by a signaller, and except at a few stations the observations were satisfactory throughout the year.

79. By permission of the Postal Department meteorological observatories are established at eighteen combined postal and telegraph offices. Observations at the great majority of these stations are taken by one of the telegraph signallers, but in one or two cases by the postmasters. With certain exceptions these observatories also worked satisfactorily during the year.

80. Daily weather telegrams from Aden were sent free of charge to Bombay by the Eastern Telegraph Company during the year, and the Department is greatly indebted to the Eastern Telegraph Department for this valuable concession as well as for the rapid transmission of the messages.

81. The observatories at Baghdad, Ispahan, Tehran, Meshed, Muscat, Jask and Bushire furnished valuable observations throughout the year. Daily weather telegrams were transmitted as far as Karachi, free of cost to the Department, from Muscat, Bushire and Jask throughout the year, and from Meshed, Ispahan, Tehran and Baghdad from the beginning of November to the end of the official year. These telegrams were forwarded from Karachi to Simla in the same manner as Indian weather telegrams, and were very useful in forecasting the approach of cold weather storms from Persia to northern India. The Department is greatly indebted to the Directors of the Persian Gulf Section and of the Persian Section of the Indo-European telegraph line for the continuance of this valuable concession.

82. Weekly telegrams were received from the 2nd May to the 17th October from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams gave valuable information of the weather conditions in the Indian Ocean and the Department is indebted to the officers for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the India Meteorological Department.

83. The Department is greatly indebted for important information as to meteorological conditions prevailing antecedent to and during the south-west monsoon, to the Director of the Government Observatory, Durban; Mr. J. McClounie, head of the Scientific Department, Zomba, British Central Africa; the Meteorologist, Dar-es-Salaam; His Majesty's Commissioner, Entebbe, Uganda; the Director General, Survey Department, Cairo; the Commonwealth Meteorologist, Melbourne; the Directors of the Observatories at Buenos Ayres and Santiago; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

GILBERT T. WALKER,

Director General of Observatories.

METEOROLOGICAL OFFICE, SIMLA;
The 26th August 1909.

REPORT

ON

THE ADMINISTRATION

OF

THE METEOROLOGICAL DEPARTMENT

OF

THE GOVERNMENT OF INDIA

IN

1909-10.

Changes in the Staff during the Year.

The services of Mr. Michie Smith were extended for a further period of 6 months from the 13th July 1910 to 12th January 1911.

2. Mr. Patterson went on privilege leave for 2 months and 21 days combined with special leave for 3 months and 9 days from 19th March 1909. Leave was extended on medical certificate up to 27th November 1909. Mr. Bion acted as Imperial Meteorologist.

3. Dr. Simpson went on privilege leave for 3 months from 2nd December 1909 to 1st March 1910, and on leave without pay for 3 years from 2nd March 1910. Mr. Bion acted as Imperial Meteorologist during Dr. Simpson's period of privilege leave.

4. Mr. N. U. K. Leslie went on privilege leave for 1 month and 21 days combined with furlough for 22 months and 9 days from 5th February 1910. Mr. H. A. Armstrong was appointed to act as Meteorologist, Bombay.

5. Dr. E. G. Hill, Meteorologist, Allahabad, proceeded on leave from 26th May 1909 to 16th July 1909. Dr. A. P. Sircar acted during his absence.

6. Mr. C. W. Peake went on leave from 24th March 1909 to 12th December 1909. Dr. E. P. Harrison acted.

Observatories.

7. The observatories maintained by the Government of India are classified as follows :—

First Class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, and wind direction and velocity in addition to instruments read by eye.

Second Class.—Obervatories at which readings are taken daily at 8 hrs., 10 hrs. and 16 hrs.: those at 8 hrs. are (with a few exceptions) transmitted by telegram to one or more of the offices at Simla, Calcutta, Bombay and Madras for inclusion in the India or provincial Daily Weather Reports.

Third Class.—Observatories—

(*a*) where readings are taken daily at 8 hrs. only ; in those stations where there are telegraph offices the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports ;

(*b*) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only ; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determination of monthly and daily means which should be comparable with the means already obtained for second class observatories.

Fourth Class.—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only, are recorded.

8. At the commencement of the year 279 observatories contributed registers of meteorological data ; of these 50 were non-departmental and 229 were maintained by the Government of India. At the end of the year the total number of observatories was 277 of which 50 were non-departmental and 227 were maintained by the Government of India. Of the 227 departmental observatories, 7 were first class, 20 second class, 179 third class and 21 fourth class.

9. The changes in non-departmental observatories during the year were the following :—

(1) A 3rd class observatory was opened at Muzaffarabad (in Kashmir) on the 1st February 1910, under the superintendence of the Medical Officer, Muzaffarabad.

(2) The 4th class observatory at Fraserganj was closed in April 1909.

(3) A 4th class observatory was established at Muhammerah on the 1st March 1910.

(4) The 3rd class observatory at Gangtok was changed from non-departmental to departmental in May 1909.

10. The following were the changes in departmental observatories during the year :—

(1) A 3rd class observatory was opened at Jagdalpur on the 13th October 1909.

(2) The observatories closed were :—

The 2nd class observatory at Periyakulam in May 1909; the 3rd class observatories at Pachbadra and Car Nicobar in November 1909, and March 1910 respectively ; and the 4th class observatory at Table Island in December 1909.

First Class Observatories.

11. The Directors of the Observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded for the information of Government. It has accordingly been ruled as unnecessary to include information relating to the working of these observatories in this Administration Report.

12. *The Alipore Observatory.*—This observatory is under the charge of the Meteorologist, Calcutta. It is furnished with a complete set of autographic instruments, including a Bergholz barograph, a Kew barograph, a Kew thermograph, a Richard thermograph, a Beckley anemograph, a Dines pressure-tube anemometer, a Beckley rain-gauge, a Michie Smith monthly rain-gauge, and a Milne horizontal pendulum seismograph.

These instruments have on the whole worked satisfactorily during the past year.

All instruments issued by the Meteorological Department are tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 598 as compared with 486 last year. Eighty-eight instruments were condemned as unfit for issue, or were repaired by the Mathematical Instrument Department or the departmental mechanic, and fifteen instruments were kept in store for future treatment.

The observatory gives mean Calcutta time to the port and shipping. Three time balls are dropped daily at 1 P.M. local mean time throughout the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioner's office and the third at the Kidderpore Docks.

This work was carried out satisfactorily on the whole, but there were 28 failures as compared with 12, the average number of the past 21 years; in all cases except one they were due to faulty behaviour of the electric or mechanical arrangements outside the observatory.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1909-1910	28	27
1908-1909	18	18
1907-1908	10	10
1906-1907	25	24

13. *The Allahabad Observatory.*—This observatory is under the charge of the Meteorologist, Allahabad. The self-recording instruments in use at the observatory were:—(1) a Beckley anemograph; (2) a Richard barograph; (3) a Richard thermograph (giving both wet and dry bulb records); and (4) a Stokes sunshine recorder.

There were also in use at the observatory (1) three solar radiation thermometers; (2) a grass thermometer for measuring terrestrial radiation; (3) one ground thermometer placed on the surface; (4) the ordinary instruments for eye observations of atmospheric pressure, temperature, vapour pressure, humidity, cloud, wind and rainfall; (5) six barometers for purposes of comparison and for use in the inspection of observatories; (6) a Marie Davy and a Duboscq nephoscope; and (7) a full set of ordinary thermometers in a second cage for purposes of comparison.

Beckley anemograph.—The instrument worked well throughout the year, except on five occasions when short breaks occurred in the trace.

Dines Pressure Anemometer.—The two pressure tube anemometers have been temporarily removed to the Muir College for experimental purposes.

Richard Barograph.—This instrument gave excellent tracings throughout the year. All the charts have been tabulated.

Richard Thermograph.—The wet bulb tracings of the thermograph have not been very satisfactory, but the dry bulb tracings, with a few exceptions, have been good.

Sunshine Recorder.—This worked continuously well.

Nephoscope.—Regular observations of clouds have been made with the Duboscq instruments.

Readings of all the eye instruments were taken every two hours, from 6 hrs. to 22 hrs. The earth thermometer on the surface was read at 6, 14 and 22 hrs.

14. *The Lahore Observatory.*—Eye observations of the ordinary meteorological instruments were taken seven times daily at this observatory as in past years, at 6, 8, 10, 14, 16, 18 and 22 hrs. Ground surface temperature was recorded four times daily, at 6, 10, 16 and 22 hrs.

The observatory is furnished with the following automatic instruments which have worked satisfactorily during the year :—

(1) Draper barograph ; (2) Richard barograph ; (3) Casella self-recording rain-gauge ; (4) Beckley anemograph ; (5) sunshine recorder.

Besides the above instruments there are in use at the observatory one grass radiation thermometer, and one nephoscope. The three maximum solar radiation thermometers and the ordinary sun thermometer (not self-registering), which were in use until the end of November 1909, were then discarded as unsatisfactory.

Character of the Work of Observation at Second and Third Class Observatories.

15. The general character of the work of the observatories, as judged by the number of mistakes made by observers, appears to have been satisfactory. The number of stations of great reliability in which either no mistake or only one has been detected in the data for the Indian Daily Weather Report was 18 as against 9 last year, while the number of stations at which more than 50 mistakes were made decreased from 19 to 11. It should be noted however that this improvement is partly due to a change in the method of assigning mistakes, an arrangement having been made whereby errors in transmission are now excluded from those attributed to the observer.

The usual list showing the number of mistakes in observation and in the preparation of telegrams for all the observatories which send weather telegrams to the Simla office, was prepared and circulated to the observatories at the end of the year under review.

Inspection of Observatories.

16. The number of visits paid to observatories during the year was 46 as compared with 65 in the previous year and an average of 76 during the past 10 years. The absence on leave of several officers during the touring season accounts for this diminution.

The Director General inspected the observatories at Calcutta, Bombay, Madras, Kodaikanal, Rangoon, Quetta and 5 others ; he also established a new observatory at Victoria Point. Mr Gaetane inspected 16, Mr. Subrahmanyam 12, Babu Joti Lal De 2, N. C. Biswas 2 and Budha Mull 2.

Six observatories were inspected twice so that the actual number visited was 40 ; of these 25 were reported as good, 11 as tolerable and 4 as bad.

Condition.	Number of Observatories inspected in					
	1909-10.	1908-09.	1907-08.	1906-07.	1905-06.	1904-05.
Good or satisfactory . . .	25	40	43	68	48	58
Tolerable	11	20	18	6	13	13
Bad	4	2	10	5	4	5
Total . .	40	62	71	79	65	76

17. In estimating the general character of the observatories from the above table it must be remembered that it is, as a rule, on account of something unsatisfactory that a visit of inspection is made. The general level of the stations is thus decidedly better than might otherwise appear. The most frequent cause of bad work is the changing of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments.

Special Observations.

18. Observations other than those recorded at regular intervals are made as follows:—

(*a*) In response to requests from the Simla or Calcutta office when weather is disturbed and storm warnings may have to be issued: such observations are always sent by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Re. 1 for each set of special observations sent at the request of either Simla or Calcutta. The number of telegrams of the latter class forwarded during this year was 434 as compared with 797 last year.

(*b*) Certain observers have been empowered, when they consider that conditions at sea are sufficiently threatening, to send of their own initiative to Simla or Calcutta a telegram containing special observations. Two occasions of this type occurred.

(*c*) In connection with flood warning a number of observers have been instructed to send telegrams announcing the occurrence of heavy rainfall to Government officers and railway engineers who desire early information. The number of telegrams so sent was 69 as compared with 62 last year.

(*d*) After earthquakes observers are instructed to send detailed information to the Simla office: 78 reports were received during the year.

Observations with Special Meteorological Instruments.

19. The following special observations were carried out during the past year at certain selected stations:—

1st.—Wind observations recorded by Beckley anemographs at 17 stations and by Dines pressure tube anemometers at 5 stations.

2nd.—Solar and terrestrial radiation observations at 11 and 12 stations respectively.

3rd.—Underground temperature observations at 3 stations.

4th.—Sunshine observations at 10 stations.

5th.—Barometric observations recorded by self-registering instruments, chiefly Richard barographs, at 39 stations.

6th.—Temperature observations recorded by self-registering instruments, chiefly Richard thermographs, at 19 stations.

Observations of Solar Energy in Absolute Units.

20. Observations were continued at Simla and Kodaikanal throughout the year when weather conditions allowed, by means of Angstrom's Electric Pyrheliometer.

Observations in the Upper Air.

21. In continuation of the experimental work with recording balloons, the objects of which were given in last year's administration report, 17 balloons with instruments were liberated at Jhang during the monsoon months, June and July, and 7 in December 1909; of the first set more than half were recovered, but only one of those in December. The heights reached during the monsoon ranged up to 12 miles, with a lowest temperature of about —107° F. and the descents

occurred at short distances from Jhang, in several cases within 10 miles of the starting point. The balloons in December all travelled eastward and their horizontal velocities indicated very high winds a few miles above the ground surface. The one instrument recovered had only reached the 6 mile level, with a lowest temperatureof—35° F., but it came down as far away as Lahore. It appears probable that the remaining instruments, which would in the ordinary course have reached much greater altitudes, were carried into the Himalayas or Tibet, and that, but for some defect in the balloon which touched ground in Lahore, no one of the seven instruments would have been heard of again.

A feature of the ascents in the monsoon was the liberation on two occasions of a pair of instruments together on the same balloon with a view of comparing the records of a pair and ascertaining to how great an extent the traces could be relied up to represent actual conditions. This question had assumed some importance in consequence of doubts which had been expressed by scientists at home as to the capabilities of instruments constructed so lightly as these must necessarily be. One pair was recovered and the two independent records were found to agree as well as could reasonably be expected.

Attention was paid throughout the year to the training of a native clerk, who had shown aptness in this work, with a view of enabling him to calibrate the instruments and liberate the balloons with native help only, in order that continuous systematic balloon work might be carried on from Jhang.

Seismograph Observations.

22. Seismological observations were recorded by two Omori-Ewing Seismographs at Simla and one at Bombay, by Milne Seismographs at Alipore (Calcutta), Kodaikanal and Colaba (Bombay), and by means of other self-registering instruments at the last named station. All the instruments worked satisfactorily throughout the year, and copies of the records of the Milne's Seismographs were transmitted to the Seismological Committee of the British Association.

Atmospheric Electricity.

23. The Benndorf self-registering electrometer was maintained in good order and gave a nearly continuous record of the potential gradient.

Marine Meteorology.

24. No change was made during the year under review in the method of collecting marine information.

At Calcutta and Bombay a clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard for the purpose of applying the necessary corrections to the readings of the logs; and after the barometer comparisons have been tabulated in the Calcutta or Bombay office a statement of the error of the ship's barometer is posted to the captain in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port but it is ample for our purposes.

The data thus obtained are utilised in the preparation of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department, and for drawing up an account of the storms of the year for publication in the Annual Summary.

25. The arrangements made with the London Meteorological Office, the Royal Alfred Observatory at Mauritius, the Weather Bureau, Washington, and the Deutsche Seewarte, Hamburg, for collecting marine data from the whole of the Indian Ocean has been continued and the thanks of this department are again due to these four offices for thus supplying a large amount of useful data.

26. Observations recorded during the year at the entrance to the River Hugli were supplied to the Meteorological Department by the light-vessels "Comet" and "Luna."

Snowfall Registration in the Mountain Districts to the North and West of India.

27. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete and the thanks of the Department are again due to the various officers who have collected and forwarded it. It is true that in some cases the information is rather untrustworthy, but experience shows that the general impression as to the snowfall over large areas is consistent with deductions from other meteorological factors. Reliable additions to the information have been obtained by continuing, though from a lower altitude, the series of large-scale photographs of the snows as seen from Simla which were started in 1905.

Rainfall Registration.

28. The registration of rainfall in India has invariably been carried out by the provincial authorities. In 1889 a uniform system was introduced by the Government of India, and the Director General of Observatories was made consulting officer in connection with this work. His advice is sought over the starting of new rain-gauge stations, and he receives annual reports from the local officers responsible for the registration of rainfall upon the efficiency of the work. A general account of the system, which came into operation in the year 1891-92, will be found on pages 5-8 of the Administration Report of the year 1889-90, or on pages 6, 7 of the Administration Report of the year 1890-91.

29. The following is a classified statement of the total number of rain-gauge stations at the end of the year in the various political divisions, and of the number of rain-gauge stations of which inspection reports were received by the Indian Meteorological Office during the year 1909-10.

Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1910.	Number of inspections of rain-gauges in 1909-10 of which copies of the reports were received in the Simla Meteorological Office.				Percentage of inspections of which copies of reports were received to total number of rain-gauges.
		Good.	Fair.	Bad.	Total.	
Burma	192	16	10	...	26	14
Eastern Bengal and Assam	245	59	6	5	70	29
Bengal	261	42	7	...	49	19
United Provinces of Agra and Oudh	277	20	1	1	22	8
Punjab	189	62	17	3	82	43
Kashmir	36	...	...	...	...	...
North-West Frontier Province.	34	...	1	...	1	3
Baluchistan	64	...	...	...	...	...
Rajputana	180	17	2	1	20	11
Bombay and Sind	289	...	...	...	...	...
Central India	115	...	...	...	...	...
Central Provinces and Berar	171	43	7	...	50	29
Hyderabad	22	...	...	...	...	...
Mysore	77	...	...	...	...	...
Madras (including Pudukkottai, Coorg, Travancore and Cochin).	502	318	99	15	432	68
Total	2,654	577	150	25	752	28

Note.—In several cases the same gauge was inspected more than once during the year.

The following paragraphs give a brief summary of the reports of rainfall registration for the year 1909-10.

30. *Burma.*—"The total number of rain-recording stations in the Province is 192 against 190 at the close of the preceding year. Of these 14 are Meteorological Observatories and 25 are under the charge of the Public Works Department."

31. *Eastern Bengal and Assam.*—The total number of stations on the 31st March 1909 was 247, of which 118 were in Eastern Bengal and 129 in Assam, as compared with 112 and 124, respectively, in the previous year. Twelve new stations were opened during the year under report. In the district of Faridpur a large number of new stations were added, the number being at present 10 against 5 in the preceding year. Out of the total number of 245 gauges 163 were inspected during the year, and 41 of these were inspected more than once: this marks a great advance on last year, when out of 322 gauges only 85 were inspected.

32. *Bengal.*—The number of stations on the 31st March was 354 but of these a large number had not been sending returns, thus in March the rainfall of only 261 stations was printed. The number of stations inspected was 74, and this work was considerably neglected in some districts, no more than one station having been inspected in the districts of Birbhum, Midnapore, Hooghly, Patna, Shahabad, Saran, Muzaffarpur, Bhagalpur, Purnea, Darjeeling, Sonthal Parganas, Balasore, and Puri, or in the Urrya Feudatory States and the Orissa Tributary Mahals.

33. *United Provinces of Agra and Ouah.*—There are now 287 rain-reporting stations in these provinces, including the meteorological observatories, all of which use gauges of the Symons pattern.

Out of the 273 stations under district and canal officers' supervision, 157 or 58 per cent. were reported as inspected during the year.

In 13 districts all the gauges were inspected, in 10 districts one station only in each was inspected and in 2 districts no inspections were made. Serious efforts are being made to secure satisfactory exposures; 5 gauges have been moved to new sites, at 10 stations trees in the vicinity of the gauges have been cut down, and at many other stations orders for improvements have been issued.

34. *Punjab.*—The total number of rain-gauge stations in the Punjab is 203 or 13 more than last year. Of these 153 are in charge of the district officers and 50 are under the canal department.

"The rain-gauges at Bhiwani and Kabirwala were fixed at more suitable places and that at Nawanshahr, which was found defective, was replaced by a new one. Necessary replacements and repairs were also done to several other rain-gauges which stood in need of them.

"The different Revenue Officers made 108 inspections during the year as against 109 made during the previous year. Besides this the Deputy Commissioners of Delhi, Amritsar, Gujarat, Shahpur, Attock, Jhang and Muzaffargarh made several inspections of which they did not submit post card inspection reports. No post card inspection reports were received at all from the Settlement Officers, Delhi and Gurdaspur, and Deputy Commissioners, Lahore, Amritsar, Sialkot, Rawalpindi and Lyallpur. My personal Assistants and I made 39 inspections only 12 Revenue Assistants out of 29 made 25 inspections during the year.

"All the rain-gauges under the charge of canal officers have been periodically inspected and have been maintained in good order throughout the year. (The tube rain-gauge at Jaman, the rain-gauges at Lalu Gudar, and Jiwan Shah in the Upper Bari Doab canal circle, and the tube rain-gauge at Laungwali in the Upper Chenab canal circle went out of order and the necessary steps were taken to get them repaired.) Most of the Watson's self-registering gauges in the Western Jamna canal circle con tinued to give trouble. The rainfall records are reported to have been neatly and properly kept.

"The rain-gauges under the District Officers are reported to be in good order. The rainfall records are properly kept up The Deputy Commissioner of Multan reports that the question of raising the number of rain-gauges in his District is under consideration."

35. *Kashmir.*—No report has been received.

36. *North-West Frontier Province.*—No report has been received.

37. *Baluchistan.*—No report has been received.

38. *Rajputana.*—No report has been received.

39. *Bombay and Sind.*—"The total number of rain-gauge stations in the Presidency and Native States which reported rainfall to this office was 336, the same as in the preceding year."

"Out of the total of 275 gauges in the Pesidency, 186 or about 68 per cent., as against 183 or about 66 per cent. last year, were brought under inspection. 74 of these were inspected more than once and the total number of inspections amounted to 282 as against 289 in the previous year. Sufficient attention does not appear to have been paid to this work in 3 districts in the Deccan, and 2 districts each in the Karnatak, Konkan and Gujarat and 1 district in Sind. The attention of the Collectors concerned is being invited to it."

Inspection in the Native States maintained the improvement shown last year, 43 out of a total of 61 rain-gauges, or nearly 70 per cent., having come under inspection this year; 7 gauges were inspected more than once, the total number of inspections amounting to 51.

40. *Central India.*—No report has been received.

41. *Central Provinces and Berar.*—"The number of rain-gauges maintained during the year was 107 against 105 in the previous year. Of this number 11 were observatories under the control of the Meteorological Department; 26 were managed by the Medical Department, 15 were maintained by Feudatory States and 55 were in charge of Kanungos, Police Muharrirs and School Masters.

"The number of inspections of rain-gauge stations in the Central Provinces during the year, of which reports were received, was 125 against 148 in the preceding year and 130 in 1907-08.

"The number of rain-gauges in Berar during the year remained the same, namely 44. Of this number 4 were observatories under the control of the Meteorological Department and of the remaining 40, which are under the control of the Director of Land Records, Central Provinces, 37 are supervised by the Civil Surgeons and Hospital Assistants and 3 by Tehsildars. The number of inspections of rain-gauge stations during the year was 154 against 129 in the previous year."

42. *Hyderabad.*—No report has been received.

43. *Mysore.*—No report has been received.

44. *Madras.*—"On the 31st March 1909 there were 476 rain recording stations excluding the meteorological observatories furnishing rainfall returns for publication in the Fort St. George Gazette. There was thus no change in the number of stations at the end of the year. Of the 392 stations in the Presidency 355 were inspected, *i.e.*, 91 per cent." The amount of inspection in Madras continues very satisfactory.

45. *Summary.*—The work of rainfall registration continues to be carried on in a satisfactory manner; and there is evidence of increased realization of the need of regular inspection in order that reliable results may be secured.

Storm Warnings.

46. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed by two offices. Ports on the Bay of Bengal are warned from the Calcutta Office by the Meteorologist, Calcutta, and ports on the Arabian Sea from the Simla Office by the Director General of Observatories,

The complete system at present in operation includes :—

1st.—An extended system of storm signals for use at the larger and more important ports.

2nd.—A brief system of storm signals for use at the smaller ports, chiefly for the information of native vessels and local traffic.

47. *Bay of Bengal Storm Signal Service.*—The following is a list of the ports for the warning of which during the year 1909-10 the Meteorologist, Calcutta, was responsible—

Port Blair.	Akyab.	Chandbali.	Cocanada.
Mergui.	Chittagong.	False Point.	Masulipatam.
Tavoy.	Narayanganj.	Puri.	Madras.
Moulmein.	Barisal.	Gopalpur.	Cuddalore.
	Noakhali.		
	Goalundo.		
	Calcutta and River Hooghly.		
	Balasore.		
Rangoon.		Calingapatam.	Negapatam.
Bassein.		Vizagapatam.	Pamban.

Tuticorin. | Colombo.

To these Diamond Island was added during the year.

Telegraphic information is also sent to Chittagong, Narayanganj, Barisal and the Orissa ports whenever storm signals are hoisted or lowered at Saugor Island ; and to Bassein when signals are hoisted or lowered at Diamond Island.

It may be noted that in the case of the Bengal ports and Port Blair the signals are hoisted by the direct orders of the Meteorologist, Calcutta.

In the case of the Burma and Coromandel coast ports the responsibility of the Meteorologist, Calcutta, has been hitherto limited to giving as full and definite information as was possible respecting storms to the port authorities, leaving the question of hoisting and lowering storm signals to their discretion, but from September last the Meteorologist, Calcutta, has been instructed by the Director General of Observatories to suggest the particular storm signal to be hoisted. This change has been made in consultation with the local Governments in order to fix more definitely the responsibility for hoisting the signals.

Storm signals were hoisted on seven occasions and in addition various ports were warned by cautionary telegrams on nine occasions during the storm season. The weather was disturbed by depressions on ten occasions, and five times the depression developed into a cyclonic storm.

48. There are also special arrangements at Calcutta for supplying daily to Saugor Island and to certain ports in the Bay information as to the state of the weather in the Bay at 8 A M., for the benefit of shipping. This information is given partly by a system of flag signal messages indicating generally the state of the weather in four sections of the Bay, and partly by means of a special code telegram in which the information is of a more detailed character.

The daily flag signal message was sent to Saugor Island throughout the year and to Elephant Point from the 1st April 1909 to the 14th January 1910 only. This message was also sent to the Port Officer, Rangoon, during the period 15th January to 31st March.

During the past year arrangements were made at Diamond Island for the exhibition of the flag signals relating to the weather in the four sections of

the Bay of Bengal from 1st April to 14th January each year. The system was initiated on the 20th September.

The following officers were supplied with the flag signals and the daily weather telegram from 1st April 1909 to 14th January 1910:—

Port Officer, Rangoon.
Deputy Port Conservator, Rangoon.
Port Officer, Cocanada.
Port Officer, Cuddalore.
Ditto, Negapatam.
Port Conservator, Porto Novo.
Deputy Port Conservator, Madras.

At the request of the Secretary to the Port Commissioners, Rangoon, the daily weather telegram hitherto sent to his address was discontinued and the name of the Deputy Port Conservator, Rangoon, was added to the list of officers receiving the telegram. The Deputy Port Conservator, Rangoon, is also informed of all storms in any part of the Bay of Bengal.

The following officers received the daily weather telegram only during the period mentioned above, *viz.*, from 1st April 1909 to 14th January 1910:—

Port Officer, Moulmein.
Ditto, Akyab.
Ditto, Gopalpur.
Ditto, Vizagapatam.

The Port Officer, Chittagong, received the daily weather telegram and the flag signal message from 16th May to 15th November.

The telegram was also sent to the Port Conservator, Calingapatam, on Sundays, Wednesdays, and Thursdays.

49. The following officers were added to the list of officers receiving warning telegrams during bad weather or cyclonic storms :—

Superintendent of Telegraphs, South Indian Division, Trichinopoly.
Ditto, Eastern Bengal Division, Barrackpore.
Ditto, Arakan „ Akyab.
Ditto, Lower Burma „ Rangoon.
Director of Telegraphs, Construction Branch, Calcutta.
Executive Engineer, Lower Ganges Bridge, Damukdia.
Traffic Superintendent, Goalundo.

50. It has been decided to send to the daily papers for publication in the next morning's issue a note based on the storm observations recorded at 20 hrs., whenever a storm of importance is threatening Calcutta or the mouth of the Hooghly.

51. Arrangements were made in 1905 for the transmission by wireless telegraphy of the 8 hrs. observations from Port Blair and Slipper Island, and of special observations in the case of unsettled conditions in the Bay of Bengal. The service worked in a most satisfactory manner during practically the whole of the year 1909-10, and the information that it conveyed again proved of the greatest value in connection with the daily weather reports of Simla, Calcutta and Madras, as well as in the more important work of warning for storms in the Bay.

52. *Arabian Sea Storm Signal Service*.—The work of warning the Arabian Sea ports was carried out during the past year by the Simla Meteorological Office, which also warned the Madras ports on the Malabar coast in the same manner as the Meteorologist, Calcutta, warned the Madras ports on the coast of the Bay of Bengal. Warnings of storms in the Arabian Sea were also sent to the Port Officer, Aden, for the information of steamers leaving that port for the Superintendent, Colombo, Bombay and Karachi. Copies of all warnings sent to the Malabar ports were forwarded for information to the Master Attendant, Colombo, Meteorological Observatory, Colombo, the Commercial Agent to the Diwan of Alleppi, the Presidency Port Officer, Madras, the Deputy Port Conservator, Madras, and the Chief Engineer for Irrigation, Madras.

Warnings were also sent to the Dewan of Junagadh, the Superintendent of Telegraphs, Gujarat Division, the Sub-divisional Officer, Sacrifice Rock Lighthouse, Badagara, and indirectly through the Commander of the Port, Mormugao, to the Portuguese Port of Diu.

The following is a list of the Bombay and Malabar ports for the warning of which during the year 1909-10 the Simla Meteorological Office was responsible :—

I.—By extended system.	II.—By brief system.	
Karachi.	Cutch-Nandvi.	Murud Janjira.
Bombay.	Jamnagar.	Ratnagiri.
Mormugao.	Dwarka.	Harnai.
Mangalore.	Porbandar.	Mulwan.
Tellicherry.	Veraval.	Goa.
Calicut.	Jafrabad.	Vengurla.
Cochin.	Bhavnagar.	Karwar.
	Daman.	Kumta.
	Alibag.	Honavar.

53. In 1909-10 there were ten periods of disturbed conditions in the Arabian Sea for which warnings were issued, but only one was of importance. Early in May a depression crossed the south of the peninsula from the Bay of Bengal and on the 8th passed out into the Arabian Sea near Mangalore; thence it moved northwards to the vicinity of Gujarat and disappeared. Its high winds did much damage to native shipping at Calicut and considerable damage to bridges and roads in the inland portion of the district: in the other Malabar ports the damage to shipping was on a smaller scale.

54. In view of the entirely exceptional character of the weather and the success with which the departmental warnings were utilised in the South Canara district some further details are here given. At Calicut the warning from Simla of the approach of the storm arrived at noon on the 5th and after 1 P.M. the

wind gradually increased in strength until it became a gale with high seas: the storm raged heavily until the 7th by which time about 45 native boats had been wrecked. It is an open roadstead and there was nowhere to run to for shelter. At Mangalore however there is a backwater and it was possible on receipt of the warnings to make vessels secure in the harbour; consequently only two native boats were wrecked although on the night of the 7th it was blowing a hurricane with terrific squalls. The Collector of South Canara estimated the loss through wrecking of native boats in the district at between Rs. 50,000 and Rs. 70,000, and reported "were it not for the timely warning given to all the ports and to the divisional officers in the district, who communicated it to the public, the loss of life and property would have been, perhaps, enormous."

55. Until the present year it has been considered that the local signs of the approach of the monsoon on the west coast were sufficiently marked, and that it was not necessary for this department to send warnings of the squally weather usually associated with its oncoming. In August last however it was decided that at such times telegraphic information should as far as possible be provided from Simla.

Flood Warnings and Weather Forecasts to District, Irrigation, Railway and other Officers.

56. This work is carried out chiefly by the Simla Meteorological Office, but partly by that of Calcutta. The arrangements for it have been sanctioned at various times, and differ considerably in character, according to the nature and extent of the flood or weather warnings required by the officers concerned. In some cases these officers require telegrams warning them of advancing storms likely to give heavy rain, or of actual heavy rainfall, likely to give rise to severe floods which might injure railways or canal works; and in others they require warnings or forecasts of the weather for as long a period beforehand as possible, so as to enable them to modify their arrangements for carrying on the works under their charge so far as may be necessitated by sudden or large changes of weather.

57. The number of district officers and officers in the irrigation, railway and other departments requiring warnings from Simla amounted at the end of the year to 93, an increase of 5 during the year.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Karachi, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

The number of special warning messages sent from Simla during the year 1909-10, was 941 as compared with 1,199 in 1908-09 and 1,149 in the year before.

58. Warnings of floods or of heavy rainfall were issued by the Meteorologist, Calcutta, to 41 officers of the Public Works, Telegraphs and other Departments, chiefly in Bengal and on the east coast.

59. Instructions were issued nine years ago by the Government of India that every officer to whom storm or flood warnings are issued, should in the month of January of each year or in the case of military expeditions at the close of the campaign, forward to the head of this department a brief return of the warnings received during the past year and should also report:—

(1) Whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

(2) Whether the warnings were timely and satisfactory in every respect, and, if not, in what points they were defective.

(3) Whether any changes might be made in the system which would make the warnings more useful.

Reports on the storm and flood warnings for the calendar year 1909 were received from 56 officers. Of these 29 reported that the warnings were timely and satisfactory and were rapidly transmitted by the Telegraph Department;

23 offered no remarks and 4 officers reported that they had received no warnings during the year. No suggestions were made for improving the usefulness of the Flood Warning Service.

The general impression given by the reports is that the system works as well as can reasonably be expected except in the forecasts of cold weather rainfall in Baluchistan. The information available for that area is inadequate, and arrangements are being made for opening new stations at Fort Sandeman, Kalat, Dalbandin, Panjgur and Pasni.

Seasonal Forecasts.

60. The forecast for the monsoon period of 1909, dated the 8th June, was sent to Local Governments and Administrations, communicated to the press and printed in the Gazette. A statement of the rainfall of June and July with a forecast for August and September was drawn up on the 6th August and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was drawn up on the 16th December 1909 and sent to Local Governments and Administrations.

The chief points in the June forecast were (*a*) that the total monsoon rainfall would be of 'more than the average amount', and (*b*) that the 'outlook for the plains of northwest India during the early part of the season' was 'somewhat less favourable than that for the field of the Bay current.' Both of these proved to be correct.

The August forecast anticipated (*a*) a continuation of the favourable conditions with an excess of the total rainfall during August and September, and (*b*) no marked abnormalities in the geographical distribution of rainfall.

Of these (*a*) was somewhat too sanguine, for though the rainfall was very favourable from the agricultural standpoint its total for the two months was in defect by 2 per cent., (*b*) was fairly correct, for though individual provinces were in excess or defect there was no big excess or defect extending over a large area of the country.

61. A memorandum on the weather during November and December 1909, with a forecast of that of January and February 1910, was prepared on the 4th January and issued in the same manner as the forcecast of the previous June. The anticipation was that the total precipitation of northwest India would reach or exceed the average.

On the 5th May 1910 a comparison of the actual precipitation with the above forecast was issued, and it was pointed out that the number of depressions had been fully up to the average, though their tracks were farther north than usual: thus snowfall was as abundant as usual, but the rainfall in north-west India was in defect except in the North-West Frontier Province.

Daily Telegraphic Weather Summary.

62. The summary was despatched daily at about noon.

It was posted at certain telegraph offices, and sent to 87 servants of Government. The number of subscribers was as follows:—

Subscribers.	Number during monsoon period of 1909.	Number on 31st March 1910.
Newspapers	7	7
Private individuals ...	13	3

PUBLICATIONS.

A.—Weather Reports.

63. *India Weather Reports.*—The following weather reports, giving information of the current weather to the Government and the public, were published during the year by the Simla Meteorological Office:—

(1) India Daily Weather Report.

(2) India Weekly Weather Report, giving an account of the weather and of the rainfall of the week ending on the previous Thursday, published in the *Gazette of India* every Saturday.

(3) Monthly Supplement to the India Daily Weather Report, published about the 4th of the succeeding month.

(4) Annual Supplement to the Daily Weather Report.

(5) India Monthly Weather Review, giving a general summary of all the important features of the weather and complete meteorological data of the month; the data for this are not at once available and it is usually published three months after date.

(6) Annual Summary of the Monthly Weather Reviews.

For a detailed description of the contents of these publications reference may be made to the departmental Administration Report for 1907-08.

64. *India Daily Weather Report.*—The number of stations for which data were given in the daily report of the 31st of March 1910 was 176. The following table shows the distribution of the reports:—

	Number of Recipients on the 31st March.					
	1910.	1909.	1908.	1906.	1904.	1902.
Government Officers	514	509	461	416	398	372
Foreign Recipients	45	46	46	45	46	40
Newspapers	2	2	2	2	2	2
Subscribers	17	18	20	14	13	13
	578	575	529	477	459	427

The number of subscribers during the monsoon period of 1909 was 44.

65. *Annual Summary.*—The annual summary of the meteorology of India for 1908, supplementing the Monthly Weather Reviews for that year, was issued in October 1909. It contains mean data for the year and a discussion of its more important meteorological features together with their mutual relations. A summary of the meteorology of the year 1908 was also prepared for the Sanitary Commissioner with the Government of India, and was given as Chapter I of the Annual Report of that officer for the year.

66. *Special Charts.*—The Simla Office prepared, throughout the year, weekly charts showing the character of the rainfall of each week and of the seasonal rainfall up to date, for the use of His Excellency the Viceroy, His Majesty's Under-Secretary of State for India, London, the Hon'ble the Finance Member and the Secretary to the Government of India in the Revenue and Agricultural Department.

67. *Provincial Weather Reports.*—The following provincial reports were issued by the local meteorologists during the year:—

(1) By the Meteorologist, Calcutta—

(*a*) Calcutta Daily Weather Report.

(*b*) Meteorological Table for Bengal and Assam, with a summary of the chief features of the weather for the month, published regularly in the *Calcutta Gazette.*

(*c*) The supplementary weekly meteorological and rainfall table containing temperature and rainfall observations recorded at 19 stations in Bengal and in Eastern Bengal and Assam, issued to all subscribers of the Calcutta Weather Report on every Wednesday throughout the year.

(2) By the Meteorologist, Bombay—

(*a*) Bombay Daily Weather Report.

(*b*) Monthly abstracts of meteorological observations published in the Bombay Government *Gazette.*

(3) By the Meteorologist, Madras—

(*a*) Madras Daily Weather Report.

(*b*) Monthly Rainfall Tables for Madras, Coorg, Pudukkottai, Cochin and Travancore, published in the Provincial *Gazette.*

(4) By the Meteorologist, Allahabad—

(*a*) Monthly Weather Summary of the province published in the Provincial *Gazette.*

(*b*) Brief sketch of the meteorology of the province for the year 1908

(*c*) Monthly Rainfall Tables for the United Provinces of Agra and Oudh, published in the Provincial *Gazette.*

(5) By the Simla Office—

(*a*) Monthly Summary of the weather of the Punjab, published in the Provincial *Gazette.*

(*b*) Annual Meteorological Summary of the Punjab for the year 1908-09.

B.—Memoirs of the Ind ian Meteorological Department.

68. The following were published during the year 1909-10 :—

(1) A discussion of the anemographic observations recorded at Roorkee, from September, 1879, to August, 1904; at Lahore from June, 1889, to May, 1905; and at Mussooree from May to October, 1877—1888, by the late Sir John Eliot, M.A., F.R.S., K.C.I.E., late Meteorological Reporter to the Government of India and Director-General of Indian Observatories. (Memoirs of the Indian Meteorological Department, Vol. XVIII, Part IV.)

(2) A discussion of the anemographic observations recorded at Pachmarhi from September, 1883, to April, 1887, and at Nagpur from January, 1882, to December, 1902, by the late Sir John Eliot, M.A., F.R.S., K.C.I.E., late Meteorological Reporter to the Government of India and Director-General of Indian Observatories. (Memoirs of the Indian Meteorological Department, Vol. XIX, Part I.)

(3) The Simla seismograms obtained between June, 1905, and November, 1908, by J. Patterson, M.A., Imperial Meteorologist. (Memoirs of the Indian Meteorological Department, Vol. XX, Part III.)

(4) On the meteorological evidence for supposed changes of climate in India by Gilbert T. Walker, M.A., Sc.D., F.R.S., Director-General of Observatories. (Memoirs of the Indian Meteorological Department, Vol. XXI, Part I.)

C.—Other Publications.

69. (1) Telegraphic Code and instructions for the use of the Indian Meteorological Department during stormy and suspicious weather (second edition).

(2) Tables for the reduction of meteorological observations in India (revised and enlarged edition).

Supply of Meteorological Information.

70. In addition to the meteorological information published by the department the following special information was supplied to other meteorological institutions :—

(*a*) Weekly telegrams containing weekly pressure departures from normal of Bombay, Seychelles, Zanzibar and Aden were sent to the Director General, Survey Department, Cairo, during the monsoon period.

(*b*) Monthly telegrams were sent to the Meteorological Office, London, during the monsoon period giving information of the state of the Arabian Sea and Bay of Bengal for insertion in their monthly pilot charts.

(*c*) Monthly telegrams were sent to the Solar Physics Committee, London, throughout the year giving the mean monthly pressure of Bombay.

(*d*) Monthly telegrams were sent to the Meteorological Department, Melbourne, Australia, throughout the year giving the monthly mean pressure and temperature departures from normal of India, and a short description of the general condition of weather.

(*e*) Weekly code telegrams were sent during the monsoon period from Simla to the Calcutta Meteorological Office for drawing up a table of rainfall, humidity and temperature at 100 representative stations in India, to be published by the Director General of Commercial Intelligence in the *Indian Trade Journal.*

71. Climatological information, at times involving special calculation, is also provided for sanitary and other officers of Government, as well as to private firms. The extent to which the Department is utilised in this manner is increasing steadily.

Miscellaneous.

72. Nine hundred and eight books and pamphlets, either purchased or presented by scientific bodies, were added to the Library during the year. The Library is on the whole in fair order.

73 Thirteen libraries, observatories or societies were added during the year to the list of institutions to which the publications of the India Meteorological Department are supplied, and six were removed; the number on the list is now 384.

Chief Features of the Year.

74. The work of the department falls naturally into two parts, the directly useful and the purely scientific which aims at ascertaining facts which shall be of practical usefulness in future. The former part consists chiefly of the collection and distribution of current weather information, the supply of climatological data, the sending of storm and flood warnings and the provision of time signals. On the other hand the scientific work includes the experimental and theoretical examination of the physical processes, on the earth or the sun, which determine the weather.

Owing to the abnormally large number of violent storms during the year the work of notifying the ports assumed exceptional importance. Information regarding the usefulness of the warnings of the storm in May on the Malabar coast has been given in paragraph 54. In the Bay of Bengal the most important storms were those which struck Goalundo and Gopalpur in October and Cox's

Bazar in December. The Meteorologist, Calcutta, was on leave from March to December and the warnings issued by his substitute were very useful; in spite of the unusual characters of the storms he formed fairly correct estimates of their paths. But considering the enormous interests at stake it may be doubted whether a system is adequate which may place work of this difficult and fatiguing nature into the hands of a comparatively inexperienced half-time officer who has other important duties to attend to. Perhaps the chief difficulty in the past in ascertaining the position and magnitude of a storm in the Andaman Sea has been the bad exposure of the wind instruments at Mergui, Tavoy and Moulmein, and the entire lack of information as to the state of the sea along the Tenasserim coast. A tower for the wind instruments has therefore been erected at Tavoy and the observatory at Mergui has been transferred to the wireless telegraph station; a new observatory has been opened at Victoria Point at the extreme south of Tenasserim, and arrangements have been made for a station at Amherst, near Moulmein, which shall telegraph the state of the wind and sea.

The work of issuing predictions of heavy rain to officers requiring it, or information of unusual precipitation which has actually occurred, has been in general carried out with as much success as can reasonably be expected. The only district where the system has seemed unsatisfactory has been Baluchistan, and there our stations, Quetta and Chaman, have not been nearly adequate to represent the area: the head of the department accordingly visited Quetta and availed himself of the keen interest in meteorological matters of the Agent to the Governor General who agreed to the starting of five new telegraphically reporting stations, and to their regular inspection by his officers. An observatory has been started at Jagdalpur and is of considerable importance when depressions from the Bay are passing into the Central Provinces; and, on the other hand, savings have been effected by the closing of the observatories at Car Nicobar, Cocos Island, Fraserganj, Pachpadra and Periyakulam, from which the data had become unnecessary or worthless.

A conspicuous growth in the departmental correspondence has occurred in connection with requests for information, in general of a statistical character, from officers interested in the relations of weather and disease, or from commercial firms wishing to start factories requiring special conditions. The amount of work involved has at times been considerable.

Turning to more directly scientific work, progress has been made by Mr. Field in his examination of the conditions in the upper air. Almost every civilised country is now conducting regular observations with balloons or kites and as the monsoon is brought by one of the largest of the air currents it is of importance for India that knowledge should be gained of the factors determining the general circulation. The work of the year, described in paragraph 21, has brought out a striking difference between the upper winds in the rains and in the cold weather; and it is hoped that the Indian clerk who has been trained to calibrate the instruments and send up the balloons may enable observations to be made regularly in future.

The experiments upon which Dr. Simpson had based his explanation of the electricity in thunderstorms were repeated during the year and were applied to snow storms; the electrification in the latter case was found to be produced under conditions generally similar to those in the case of rain.

It has at times been maintained that the climate of northwest India was changing owing to the increase in the extent protected by canals, or to the destruction of forests; and a memoir was published during the year in which the meteorological evidence was examined. It appears that the rainfall records give no justification for believing in a permanent change, and that for such temporary variation as has occurred during the past 40 years human agency is not responsible to any appreciable extent. This conclusion is not, of course, opposed to the fact that the destruction of forests in India leads to the washing away of valuable soil, and so causes the rainfall to run off more rapidly into the rivers and to be less useful for the growth of crops.

Fresh advances have been made at Kodaikanal in our knowledge of conditions upon the sun, and a summary of the recent important researches has been published as the first of the memoirs of the observatory. Mr. Evershed has established the existence of an inward movement of the gases above a sunspot, in addition to the outward movement of the lower gases previously announced.

The department has for three years lost the services of Dr. Simpson. The Royal Society regarded him as the most useful officer fitted to take charge of the physical researches to be made during the approaching attempt to reach the South Pole, and on their application he was granted the necessary extraordinary leave. The temporary vacancy is being filled by Mr. Harwood, who, like Dr. Simpson, was formerly a pupil of Professor Schuster of Manchester.

Concluding Remarks.

75. The Meteorological Department again received valuable assistance in its work from the Medical, Telegraph and Postal Departments during the year.

76. The importance of collecting meteorological information has always been realised by medical officers in India, and many of our observatories are in hospitals with the Civil Surgeon as our Superintendent. As the work of seeing that the observer performs his duties properly is entirely unpaid, our thanks are specially due to the officers of the Medical Department.

77. The Telegraph Department has continued to assist the Department by the rapid transmission of daily weather telegrams, and of storm and flood warning telegrams. There are in all 23 observatories established at departmental telegraph offices, the observation being taken either by the telegraph master or by a signaller, and except at a few stations the observations were satisfactory throughout the year.

78. By permission of the Postal Department meteorological observatories are established at eighteen combined postal and telegraph offices. Observations at the great majority of these stations are taken by one of the telegraph signallers, but in one or two cases by the postmasters. With certain exceptions these observatories also worked satisfactorily during the year.

79. Daily weather telegrams from Aden were sent free of charge to Bombay by the Eastern Telegraph Company during the year, and the Department is greatly indebted to the Eastern Telegraph Department for this valuable concession as well as for the rapid transmission of the messages.

80. The observatories at Baghdad, Ispahan, Tehran, Meshed, Muscat, Jask and Bushire furnished valuable observations throughout the year. Daily weather telegrams were transmitted as far as Karachi, free of cost to the Department, from Muscat, Bushire and Jask throughout the year, and from Meshed, Ispahan, Tehran and Baghdad from the beginning of November to the end of the official year. These telegrams were forwarded from Karachi to Simla in the same manner as Indian weather telegrams, and were very useful in forecasting the approach of cold weather storms from Persia to northern India. The Department is greatly indebted to the Directors of the Persian Gulf Section and of the Persian Section of the Indo-European telegraph line for the continuance of this valuable concession.

81. Weekly telegrams were received from the 1st May to the 23rd October from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams gave valuable information of the weather conditions in the Indian Ocean and the Department is indebted to the officers for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the India Meteorological Department.

82. The Department is greatly indebted for important information, as to meteorological conditions prevailing antecedent to and during the south-west monsoon, to the Director of the Government Observatory, Durban; the

Director, Agriculture and Forestry Department, Zomba, British Central Africa; the Meteorologist, Dar-es-Salaam; His Majesty's Commissioner, Entebbe, Uganda; the Director General, Survey Department, Cairo; the Commonwealth Meteorologist, Melbourne; the Directors of the Observatories at Buenos Ayres and Santiago; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

GILBERT T. WALKER,

Director General of Observatories.

METEOROLOGICAL OFFICE, SIMLA;

The 9th September 1910.

G. C. B. P., Simla.—No. 285 M. R. G. I.—30-9-10,—280.—R. G. G.

REPORT

ON

THE ADMINISTRATION

OF

THE METEOROLOGICAL DEPARTMENT

OF

THE GOVERNMENT OF INDIA

IN

1910-11.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

CHANGES IN THE STAFF DURING THE YEAR.

Mr. W. A. Harwood was appointed to act as Imperial Meteorologist for three years from the 15th April in place of Dr. Simpson on leave without pay.

2. Mr. R. Ll. Jones went on leave from the 29th April to the 9th of July, Mr. E. B. Ross acting.

3. Dr. E. G. Hill went on leave from the 29th April to the 3rd of November, Mr. J. J. Durack acting.

4. Mr. J. Patterson resigned his post of Imperial Meteorologist from the 6th May.

5. Mr. J. Evershed went on privilege leave from the 20th May to the 19th of August.

6. Mr. J. H. Field went on privilege leave from the 7th December to the 20th December.

7. Mr. C. Michie Smith retired on pension from the 13th January, but was kept on special duty at Kodaikanal till the 31st March.

8. Mr. T. Royds was appointed Assistant Director, Kodaikanal Observatory from the 28th February.

OBSERVATORIES.

9. The observatories maintained by the Government of India are classified as follows :—

First Class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, and wind direction and velocity, in addition to instruments read by eye.

Second Class.—Observatories at which readings are taken daily at 8 hrs., 10 hrs., and 16 hrs. : those at 8 hrs. are (with a few exceptions) transmitted by telegram to one or more of the offices at Simla, Calcutta, Bombay and Madras for inclusion in the India or Provincial Daily Weather Reports.

134425

Third Class.—Observatories—

(*a*) where readings are taken daily at 8 hrs. only; in those stations where there are telegraph offices the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports;

(*b*) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determination of monthly and daily means which should be comparable with the means already obtained for second class observatories.

Fourth Class.—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only, are recorded.

10. At the end of the year the total number of observatories was 283 of which 51 were non-departmental and 232 were maintained by the Government of India. Of the 232 departmental observatories, 7 were first class, 20 second class, 181 third class and 24 fourth class.

11. The changes in non-departmental observatories during the year were the following:—

(1) A fourth class observatory was opened at Jammu on the 1st May 1910 under the superintendence of the Meteorological Reporter, Jammu and Kashmir State, Srinagar.

(2) The third class observatory at Parachinar was changed from non-departmental to departmental on the 18th March 1911.

12. The following were the changes in departmental observatories during the year:—

(1) third class observatories were opened at Victoria Point and Pasni on the 5th May 1910 and 19th January 1911, respectively.

(2) fourth class observatories were opened at Guntur and Anantapur on the 8th April 1910 and 12th August 1910, respectively.

(3) The third class observatory at Kailang was changed to fourth class on the 1st June 1910.

First Class Observatories.

13. The Directors of the Observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded for the information of Government. It has accordingly been ruled as unnecessary to include information relating to the working of these observatories in this Administration Report.

The following autographic instruments were in use at the different first-class observatories during the year 1910-11.

Alipore.	Allahabad.	Lahore.
Bergholz barograph.	Beckley anemograph.	Draper barograph.
Kew barograph.	Richard barograph.	Richard barograph.
Kew thermograph.	Richard thermograph.	Casella rain-gauge.
Richard thermograph.	Stokes sunshine recorder.	Beckley anemograph.
Beckley anemograph.	Solar radiation thermometers.	Sunshine recorder.
Dines' pressure anemometer.	Grass thermometer.	Grass thermometer.
Beckley rain-gauge.	Ground thermometer.	Nephoscope.
Monthly rain-gauge.	Nephoscope.	
Hellman Fuess rain-gauge.		
Milne seismograph.		

The Alipore Observatory—This observatory is under the charge of the Meteorologist, Calcutta.

The autographic instruments have on the whole worked satisfactorily during the past year.

All instruments issued by the Meteorological Department are tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 1,098 as compared with 598 last year. Nineteen instruments were condemned as unfit for issue, or were sent to the India Office for repair and 12 instruments were kept in store for future treatment. In addition to the above instruments numbering 324 were examined before issue to other observatories.

The observatory gives mean Calcutta time to the port and shipping. Three time balls are dropped daily at 1 P.M. local mean time throughout the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore Docks.

This work was carried out satisfactorily on the whole; there were 21 failures as compared with 13, the average number of the past 22 years; in all cases they were due to defects in the electric or mechanical arrangements outside the observatory.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1910-1911	21	20
1909-1910	28	27
1908-1909	18	18
1907-1908	10	10
1906-1907	25	24

The Allahabad Observatory.—This observatory is under the charge of the Meteorologist, Allahabad.

Beckley anemograph.—The instrument worked well throughout the year, except on thirteen occasions when short breaks occurred in the trace.

Dines' pressure anemometers.—The two pressure tube anemometers which were temporarily removed to the Muir College for experimental purposes have been returned to the observatory.

Richard barograph.—This instrument gave excellent tracings throughout the year. All the charts have been tabulated.

Richard thermograph.—The wet bulb tracings of the thermograph have not been very satisfactory, but the dry bulb tracings, with a few exceptions, have been good.

Sunshine recorder.—This worked continuously well.

Nephoscope.—Regular observations of clouds have been made.

Readings of all the eye instruments were taken every two hours, from 6 hrs. to 22 hrs. The earth thermometer on the surface was read at 6, 14 and 22 hrs.

The Lahore Observatory.—Eye observations of the ordinary meteorological instruments were taken seven times daily at this observatory as in past years, at 6, 8, 10, 14, 16, 18 and 22 hrs. Ground surface temperature was recorded four times daily, at 6, 10, 16 and 22 hrs.

Character of the work of observation at Second and Third Class Observatories.

14. The general character of the work of the observatories, as judged by the number of mistakes made by observers, appears to have been satisfactory. The number of stations of great reliability, in which either no mistake or only one has been detected in the data for the Indian Daily Weather Report was 38 as against 18 last year, while the number of stations at which more than 50 mistakes were made was again 11.

The usual list showing the number of mistakes in observation and in the preparation of telegrams for all the observatories which send weather telegrams to the Simla office, was prepared and circulated to the observatories at the end of the year under review.

Inspection of Observatories.

15. The number of visits paid to observatories during the year was 58 as compared with 46 in the previous year and an average of 70 during the past 10 years. The absence on leave of several officers during the touring season accounts for this diminution from the average.

The Director General inspected the observatories at Calcutta, Bombay, Madras, and Kodaikanal; Mr. Gaetane inspected 31; Mr. Subrahmanyam 7; Babu Budha Mull 2; Mr. Hem Raj 6; Mr. C. Chengaloaraya Mudeliar 5; and Mr. W. A. Bion 7.

Kârwar was inspected twice and the visit to Pasni was made to establish the station, so that the actual number visited was 57; of these, 23 were reported as good, 31 as tolerable and 3 as bad.

Condition.	Number of observatories inspected in					
	1910-11.	1909-10.	1908-09	1907-08.	1906-07.	1905-06.
Good or satisfactory	23	25	40	43	68	48
Tolerable	31	11	20	18	6	13
Bad	3	4	2	10	5	4
Total ...	57	40	62	71	79	65

In estimating the general character of the observatories from the above table it must be remembered that it is, as a rule, on account of something unsatisfactory that a visit of inspection is made The general level of the stations is thus decidedly better than might otherwise appear. The most frequent cause of bad work is the changing of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments.

The observatories under the control of the Meteorologist, Calcutta, numbered on the 31st March, 71 *viz.*, 1 second class, 50 third class, 19 fourth class stations and 1 voluntary observatory; and of these 19 were inspected during the year by Mr. Gaetane and are included in the above statement. The observatories under the control of the Meteorologist, Bombay, numbered 23 *viz.*, 2 second class and 21 third class, and of these 7 were inspected.

Special Observations.

16. Observations other than those recorded at regular intervals are made as follows:—

(*a*) In response to requests from the Simla or Calcutta office, when weather is disturbed and storm warnings may have to be issued: such observations are always sent by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Re. 1 for each set of special observations sent at the request of either Simla or Calcutta. The number of telegrams of the latter class forwarded during this year was 648, as compared with 434 last year.

(*b*) Certain observers have been empowered, when they consider that conditions at sea are sufficiently threatening, to send of their own initiative to Simla or Calcutta a telegram containing special observations. No occasion of this type occurred.

(*c*) In connection with flood warning a number of observers have been instructed to send telegrams announcing the occurrence of heavy rainfall to Government officers and railway engineers who desire early information. The number of telegrams so sent was 108 as compared with 69 last year.

(*d*) Observers are instructed to send detailed information of earthquakes to the Simla Meteorological office and to the Director, Geological Survey, Calcutta: for this work they are paid awards from this department. 95 reports were received during the year in Simla.

OBSERVATIONS WITH SPECIAL METEOROLOGICAL INSTRUMENTS.

17. The following special observations were carried out during the past year at certain selected stations:—

1st.—Wind observations recorded by Beckley anemographs at 14 stations, and by Dines' pressure tube anemometers at 5 stations.

2nd.—Solar and terrestrial radiation observations at 2 and 12 stations respectively.

3rd.—Underground temperature observations at 3 stations.

4th.—Sunshine observations at 9 stations.

5th.—Barometric observations recorded by self-registering instruments, chiefly Richard barographs, at 36 stations.

6th.—Temperature observations recorded by self-registering instruments, chiefly Richard thermographs, at 18 stations.

OBSERVATIONS OF SOLAR ENERGY IN ABSOLUTE UNITS.

18. Observations were continued at Simla and Kodaikanal throughout the year, when weather conditions allowed, by means of Angstrom's Electric Pyrheliometer.

OBSERVATIONS IN THE UPPER AIR.

19. Owing to the changes in the gazetted staff of the department and to absence on leave, the progress of current researches was slow and little new work was possible.

The Indian observer who had been under training, as mentioned last year, was sent to Jhang in May with facilities for carrying on work with pilot balloons and recording balloon-meteorographs. His work of the former type was satisfactory and involved the use of theodolites for determining the strength, thickness, and directions of winds in the several air layers passed through by the balloons.

In regard, however, to recording meteorographs sent up on balloons, it was found that the many trifling difficulties which must necessarily arise in research operations were insuperable by correspondence, and after long trial it was reluctantly concluded that the work demanded a greater knowledge of the principles of the instruments and of the essential objects of the investigation than could be expected of an observer without a scientific education. The value of the pilot balloon observations alone was considered insufficient to justify the expenditure on the existing establishment, and the work was consequently brought to a close on the 31st March 1911.

Steps are now being taken to secure the necessary personal supervision of an organising officer during a considerable portion of the year, and it is hoped that the experimental investigation may be resumed in 1913 at Allahabad. The work will be directed chiefly towards determining the extent to which enquiry in the upper atmosphere may be expected to throw light on the problem of monsoon and other forecasting.

During the course of the pilot balloon ascents at Jhang, similar balloons were liberated on many days in Simla, and this practice was continued after the closing of the Jhang establishment.

The work of analysing the observations which have already been made is progressing, and it is hoped that it will be possible to publish the results of the analysis in the course of the year 1911-12.

Seismograph Observations.

20. Seismological observations were recorded by two Omori-Ewing seismographs at Simla, and one at Bombay; by Milne seismographs at Alipore (Calcutta), Kodaikanal and Colaba (Bombay); and by means of other self-registering instruments at the last named station. All the instruments worked satisfactorily throughout the year, and copies of the records of the Milne's seismographs were transmitted to the Seismological Committee of the British Association.

Atmospheric Electricity.

21. The Benndorf self-registering electrometer at Simla, was maintained in good order and gave a fairly continuous record of the potential gradient from 1st April 1910 to 4th January 1911, when the observations were discontinued for the remainder of the year.

Marine Meteorology.

22. No change was made during the year under review in the method of collecting marine information.

At Calcutta and Bombay a clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard, for the purpose of applying the necessary corrections to the readings in the logs; and, after the barometer comparisons have been tabulated in the Calcutta or Bombay office, a statement of the error of the ship's barometer is posted to the captain, in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port, but it is ample for the purposes of the department.

The data thus obtained are utilised in the prepartion of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department, and in drawing up an account of the storms of the year for publication in the Annual Summary.

The arrangements made with the London Meteorological Office, the Royal Alfred Observatory at Mauritius, and the Deutsche Seewarte, Hamburg, for collecting marine data from the whole of the Indian Ocean, have been continued, and the thanks of this Department are again due to these three offices for thus supplying a large amount of useful data.

Observations recorded during the year at the entrance of the River Hugli were supplied to the Meteorological Department by the light-vessels "Fame", "Comet" and "Luna."

Snowfall Registration in the Mountain Districts to the North and West of India.

23. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete, and the thanks of the Department are again due to the various officers who have collected and forwarded it. Reliable additions to the information received have been obtained by continuing, though from a lower altitude, the series of large-scale photographs of the snows, as seen from Simla, which were started in 1905.

Rainfall Registration.

24. The registration of rainfall in India has invariably been carried out by the provincial authorities. In 1889 a uniform system was introduced by the Government of India, and the Director General of Observatories was made consulting officer in connection with this work. His advice is sought regarding the starting of new raingauge stations, and he receives annual reports from the local officers responsible for the registration of rainfall upon the efficiency of the work. A general account of the system which came into operation in the year 1891-92, will be found on pages 5—8 of the Administration Report of the year 1889-90, and on pages 6, 7 of the Administration Report of the year 1890-91.

The following is a classified statement of the total number of raingauge stations at the end of the year in the various political divisions, and of the number of rain-gauge

stations of which inspection reports were received by the Indian Meteorological Office during the year 1910-11.

Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1911.	Number of inspections of rain-gauges in 1910-11 of which copies of the reports were received in the Simla Meteorological Office.				Percentage of inspections of which copies of reports were received, to total number of rain-gauges.
		Good.	Fair.	Bad.	Total	
Burma	192	6	7	...	13	7
Eastern Bengal and Assam ...	246	42	12	2	56	23
Bengal	353	38	6	1	45	12
United Provinces	278	29	5	2	36	13
Punjab	189	46	10	3	59	31
Kashmir	36	...	...	...	...	...
North-West Frontier Province ...	33	6	1	...	7	21
Baluchistan	70	...	...	...	...	...
Rajputana	185	8	...	...	8	4
Bombay and Sind	289	...	...	...	...	...
Central India	114	...	...	...	...	...
Central Provinces	171	38	10	...	48	28
Hyderabad	22	...	...	...	...	...
Mysore	77	...	...	...	...	...
Madras (including Pudukkottai, Coorg, Travancore and Cochin),	499	265	131	25	421	84
Total ...	2,754	478	182	33	693	25

NOTE—In several cases the same gauge was inspected more than once during the year.

The following paragraphs give a brief summary of the reports of rainfall registration for the year 1910-11 :—

Burma :—The total number of rain-gauge stations in the Province is 192, as at the close of last year. Of these 14 are meteorological observatories, and 26 are under the charge of the Public Works Department. The total number of rain-gauges inspected was 168, a decrease of 18 against the inspections made last year. Of these 159 were reported in good condition, 5 as fair and 4 as bad. The positions of the gauges are generally good, and where defects have been pointed out District Officers have been addressed with a view to remedying them. A new raingauge station at Lewege in the Bhamo District was sanctioned during the year. The returns are received punctually, and the inspections are satisfactory.

Eastern Bengal and Assam :—The total number of rain-recording stations was 247 or the same as last year, one new station having been opened in the Pabna district and one closed in the Khasi and Jaintia Hills. The statement giving the number of raingauges inspected shows 137 inspected and 109 not inspected. From a comparison with the similar statement for 1909-10 it would appear that the number of inspections has decreased by 26 and that nearly one-half of the gauges were not inspected during the year. The amount of inspection was particularly inadequate in the districts of Chittagong, Chittagong Hill Tracts, Hill Tippera, Mymensingh, Bakarganj, Dinajpur, Sylhet, Goalpara, Kamrup, Darrang and Sibsagar, where less than half the number of gauges were visited. The districts are now much better supplied with the proper equipment of gauges, etc., than they were two or three years ago, and steps are being taken to remedy such defects as still remain.

Bengal.—The number of stations on the 31st March 1911 was 328, and the number of stations inspected was 87, an increase of 13 as compared with the previous year. No stations were inspected in the districts of Hoogly, Muzaffarpur, Bhagalpur, Darjiling, Balasore, Puri and Ranchi.

United Provinces:—There are 288 rain-reporting stations in these Provinces, including the meteorological observatories. All are equipped with gauges of the Symons pattern. Out of the 274 stations under District and Canal officers' supervision 146, *i.e.*, 53 per cent, were reported as inspected during the year. In the districts of Gonda, Sitapur, Rai Bareilly and Benares all the rain stations were inspected during the year, while on the other hand in the districts of Bara Banki, Sultanpur, Partabgarh, Hardoi, Muttra, Pilibhit, Shahjahanpur, Budaun, Muzaffarnagar and Ballia only one station in each has been reported as inspected, and in Jaunpur and Etah no station at all. Four rain-gauges were removed to new sites, and continuous efforts are being made to secure good exposures for the gauges and to provide for their proper inspection.

Punjab:—The total number of rain gauges in the Punjab was 208, or 5 more than last year. Of these 154 are under the District Officers and 54 under the Canal Department. New rain gauges were established at Abohar, Ferozepur district, at Singhapur and Sanghi in the western Jamna Canal circle, and at Satghara and Gamber in the Lower Bari Doab Canal circle.

The rain gauges at Budhlada and Hissar have been changed to more suitable situations.

The different Revenue officers reported 62 inspections, as against 108 in the preceding year. In addition to this the Deputy Commissioners, Lahore, Gurdaspur, Delhi and Muzaffargarh made several inspections of which however no post card inspection reports were submitted. No post card inspection reports were received from Karnal, Sialkot, Jhelum or Lyallpur nor were any rain gauges inspected in the Simla district. The rain-gauges under District Officers are reported to be in good order and the rainfall records accurately kept.

From reports received from Canal Officers it would appear that all the raingauges under their charge have been inspected and have been kept in good order throughout the year, although the Watson's gauges appear to give a good deal of trouble, and often to get out of order. The rainfall records are reported to have been properly kept.

Kashmir.—No report has been received.

North-West Frontier Province.—No report has been received.

Baluchistan.—No report has been received.

Rajputana.—No report has been received.

Bombay and Sind.—The total number of raingauges reporting rainfall in the Presidency and Native States was 336, the same as last year.

Out of the 275 raingauges in the Presidency, 200, or about 73 per cent., were inspected during the year ; 85 of these were inspected more than once and the total number of inspections amounted to 308 as compared with 282 in the year 1909-10. Sufficient attention does not appear to have been paid to the work of inspection in six districts in the Deccan, in one each in the Karnatak, Konkan and Gujarat, and in three in Sind. The attention of the collectors concerned is being invited to it.

In the Native States the improvement in the work of inspection mentioned in last year's report has not been maintained. Forty out of sixty-one rain gauges, or nearly 66 per cent., having been inspected this year as against forty-three or nearly 70 per cent. last year. One gauge was inspected more than once, and the total number of inspections amounted to 43, as against 51.

Central India.—No report has been received.

Central Provinces.—The number of raingauges maintained during the year was 108, against 107 in the previous year. The number of inspections of raingauges during the year, of which reports were received, was 130, against 125 in 1909-10 and 148 in 1908-09. The raingauges at nine stations were not inspected during the year. Most of the defects detected were slight and were remedied on the spot.

Berar.—No raingauge was established or abolished during the year so that the number of raingauges remained 44, 4 being at observatories under the control of the Meteorological Department.

The number of inspections of raingauge stations was 140 against 154 in the previous year. The general results were satisfactory.

Hyderabad.—No report has been received.

Mysore.—Five new rain-gauge stations were opened during the calendar year 1910, so that at the close of the year the total number of Government stations was 227; exclusive of those maintained by a few coffee planters in their respective estates. There was a very creditable improvement in the number of inspections during the year the total being 195 out of 227, or 85·9 per cent., as against 73·9 of the previous year.

Madras.—On the 31st March 1910 there were 476 rain-recording stations (excluding those at meteorological observatories) furnishing rainfall returns for publication in the Fort St. George Gazette. The raingauges at Kota in the Nellore district, and at Ramallakota in the Kurnool district, were abolished during the year, and two other rain-recording stations were transferred from the Revenue Department to the Meteorological Department; on March 31st 1911 there were 472 rain-recording stations, *viz.*, 388 in Madras Presidency and 84 in the Native States. Of the 388 rain stations in the Madras Presidency 365, or 94 per cent. were inspected. The inspection work in Madras continues most satisfactory.

Summary.—The work of rainfall registration continues to be carried on in a satisfactory manner. In Baluchistan, in Central India and in other parts of the country the work has been placed upon a more satisfactory footing, and there is general evidence of increased realization of the need of regular inspection if reliable results are to be secured.

Storm Warnings.

25. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed from the Simla Office by the Director General of Observatories, and from the Calcutta Office by the Meteorologist, Calcutta.

The system at present in operation includes:—

1st.—An extended system of storm signals for use at the larger and more important ports.

2nd.—A brief system of storm signals for use at the smaller ports, chiefly for the information of native vessels and local traffic.

26. *Bay of Bengal Storm Signal Service.*—The ports in the following table are so arranged as to show at a glance the respective duties of the port authorities and the Meteorologist, Calcutta, in the matter of hoisting and lowering storm signals:—

Storm signals hoisted and lowered by order of Meteorologist, Calcutta.	Storm signals hoisted and lowered at the discretion of the port authority, the duty of the Meteorologist, Calcutta, being limited to giving detailed information of storms.	Storm signals hoisted and lowered by the port authorities, the Meteorologist, Calcutta, suggesting the particular signal to be hoisted.		Warnings only are sent by Meteorologist, Calcutta.
Calcutta.	Barisal.	Madras Ports.	Burma Ports.	Colombo.
Budge Budge.		Gopalpur.	Akyab.	
Mud Point.		Calingapatam.	Bassein.	
Diamond Harbour.		Vizagapatam.	Rangoon.	
Saugor Island.		Cocanada.	Moulmein.	
Chandbali.		Masulipatam.	Tavoy.	
False Point.		Madras.	Mergui.	
Balasore.		Cuddalore.		
Puri.		Negapatam.		
Chittagong.		Pamban.		
Cox's Bazar.		Tuticorin.		
Narayanganj.				
Goalundo.				
Morelganj.				
Noakhali.				
Diamond Island.				
Table Island.				
Port Blair.				

The following gives a short statement of the storms which affected the Bay of Bengal Coasts during the year 1910-11.

Number of storm.	Period of depression or storm.	Character of storm.	Coast affected.
1	13th to 16th April ..	On the 9th and 10th weather was slightly disturbed in the south-east of the Bay, and a depression formed in the neighbourhood of the Adamans on the 11th which developed into a storm on the 13th. It continued to grow during the next two days moving slowly north-east-wards, and by the morning of the 15th developed into an intense cyclone with a centre to the south-west of Diamond Island. It advanced with unusual rapidity during the day, and crossed the coast between Akyab and Kyaukpyu at about 2 hrs. of the 16th.	Arakan coast.
2	18th to 20th May ...	In the south-east of the Bay weather was unsettled on the 18th. The disturbed conditions developed on the 19th into a cyclonic storm with its centre in the neighbourhood of Moulmein. It crossed the coast during the next 24 hours, between that station and Tavoy.	Burma coast.
3	27th to 30th May ...	There was a tendency to the formation of a low pressure area in the north-west angle of the Bay on the 26th, and a well defined depression was shown to the west of Akyab on the morning of the 27th. Weather at the head of the Bay was dominated by this depression during the next 48 hours. By the morning of the 30th it had moved inland without further development, and become merged in the low pressure area in Chota Nagpur and the Central Provinces.	Arakan and Bengal coasts.
4	23rd to 26th June ...	A shallow depression formed in the neighbourhood of Gopalpur on the 23rd and remained stationary during the next 48 hours, while decreasing in intensity. It then filled up without moving inland.	Ganjam and Orissa coasts.
5	1st to 3rd July ...	A depression formed to the east of the Sandheads on the 1st. It developed into a cyclonic storm on the 2nd. Its centre at 8 hrs. on the 3rd was close to the Sandheads, and was moving slowly in a direction between west and northwest. The storm, which was then of considerable severity, crossed the coast between Balasore and Chandbali on the afternoon of the same day.	Orissa coast.
6	27th July to 3rd August.	A low pressure area was shown off Ceylon on the 22nd, and drifting slowly northwards became a shallow depression in the latitude of Nellore and Slipper Island on the 27th. The depression continued to move slowly, and lay off the Ganjam and Orissa coasts on the 31st July. On the 1st August it deepened slightly, and by the evening of the 2nd had become a storm of considerable intensity. The centre crossed the coast slightly to the south of False Point about 2 hrs. on the 3rd.	Ganjam and Orissa coasts.
7	7th and 8th August ...	On the 7th a depression formed near the Sandheads. It became slightly intensified during the next 24 hours, moving slowly in a north-westerly direction and was about 30 miles to the south-west of Calcutta at 8 hrs. of the 9th.	Bengal and Orissa coasts.
8	3rd to 8th September	A diffused low pressure area appeared off Akyab on the 3rd, and moving in a westerly direction during the next 24 hours, was in the neighbourhood of the Sandheads on the morning of the 5th. It then moved slowly in a northerly direction and at 8 hrs. on the 8th was shown with its centre close to Calcutta.	Bengal coast.
9	30th September and 1st October.	The depression which had existed in the Bay for some days previously was shown off the Ganjam coast on the morning of the 30th September. It intensified slightly during the next 24 hours, and its centre on the morning of 1st October was in the latitude of Gopalpur It crossed the coast the same night near False Point.	Ganjam and Orissa coasts.

Number of storm.	Period of depression or storm.	Character of storm.	Coast affected.
10	25th to 27th October	A depression which entered the Andaman Sea from the Gulf of Siam on the 25th October moved in a westerly direction, and crossed the coast near Negapatam on the night of the 27th October.	Coromandel coast.
11	30th October to 1st November.	On the morning of the 30th October a storm appeared to be forming with a centre close to Slipper Island. It moved in a north-westerly direction, and its centre was about 200 miles to the west of Diamond Island at 8 hrs. of the 31st. It then began to fill up, and the residual low pressure area passed over Akyab on the morning of the 2nd November.	Burma coast.
12	3rd to 6th November	A depression formed off Ceylon on the 3rd. It then gradually developed into a small but severe storm which crossed the coast near Nellore on the evening of the 6th.	Coromandel coast.
13	11th to 14th November	Conditions were disturbed in the south of the Bay on the 11th. The disturbance moved in a northerly direction during the next 24 hours. It then curved to the east and developed into a storm of moderate intensity, which crossed the coast near Akyab on the evening of the 14th.	Arakan coast.
14	22nd and 23rd November.	A depression which had existed in the south-east of the Bay for some time previously intensified slightly on the 22nd, but failed to develop into a storm and disappeared on the 24th.	Coromandel coast.

27. The following shows the action taken by the Meteorologist, Calcutta, in the case of each important storm of the foregoing list :—

(1) The storm of the 13th to 16th April was an intense cyclone, the centre of which crossed the Arakan coast on the night of the 15th—16th. The action taken with regard to Akyab, as representing the coast most affected, was as follows :—

12th April, 9·55 hrs.—"Suggest warning signal. Cyclonic storm of unknown intensity formed to West of Andamans near Port Blair; possibly already moving in some northerly direction."

13th April, 10·15 hrs.—" Storm about latitude Table Island developed into dangerous cyclone; motion still uncertain, very likely curve on to Arakan coast."

14th April, 10·46 hrs.—" Storm increased in intensity still about latitude Table Island and longitude 90° moving slowly at present. Direction still uncertain but possibly now towards North-East."

15th April, 10·5 hrs.—" Suggest great danger signal No. 3. Intense cyclone in about lat. 15° and long. 91° moving slowly north or north-east. Recommend every precaution in port."

Warning telegrams were likewise sent at 17·20 hrs. and 21·5 hrs. of 15th.

16th April, 9·35 hrs.—" Suggest lower storm signal; storm now inland."

In addition to the above, storm telegrams were sent to, and signals were hoisted where necessary at Port Blair (5), Diamond Island (5), Chittagong (3), Mergui (5), Tavoy (5), Moulmein (5), Rangoon (5), Bassein (5), Madras (5), Colombo (4), Calcutta and the River Hugli stations.

(2) A cyclonic storm was shown in the neighbourhood of Moulmein on the 19th May The action taken with regard to Moulmein, the port most affected, was as follows :—

19th May, 9·50 hrs.—" Suggest danger signal No. 3. Storm of unknown intensity near Moulmein, direction of motion uncertain; recommend precautions in port."

19th May, 12·30 hrs.—"Telegrams, received late, show that storm was of considerable intensity at eight hrs ; probably approaching and close to Moulmein."

20th May, 10·47 hrs.—"Suggest lower storm signal. Cyclonic storm Andaman Sea passed inland."

In addition to the above, storm telegrams were sent to, and signals were hoisted where necessary at, Diamond Island, Mergui, Rangoon (2) Bassein and Tavoy.

(3) This storm was unimportant.

(4) „ „ „ „

(5) The storm of the 1st to 3rd July was of considerable severity. The centre crossed the Orissa coast on the afternoon of the 3rd, and the action taken with regard to Balasore was as follows :—

2nd July, 9·40 hrs.—"Hoist danger signal No. 2, storm centre to south-east of Sandheads; may give very rough weather shortly head of Bay."

3rd July, 9·10 hrs.—"Centre of storm of some severity will probably pass over or near Balasore in two or three hours."

3rd July, 21·28 hrs.—"Lower storm signal."

4th July, 11·6 hrs.—"Storm now inland in Orissa, weather still very rough head of Bay, but will improve rapidly."

In addition to the above, storm telegrams were sent to, and signals, where necessary, were hoisted at, Rangoon (4), Akyab (3), Chittagong (4), Barisal (4), Morelganj (3), Goalundo (2), False Point (3), Puri (3), Chandballi (4) Calcutta and river stations.

(6) The storm of the 27th July to 3rd August was of considerable intensity. The centre crossed the coast near False Point about 2 A.M. of the 3rd and the action taken with regard to False Point was as follows :—

30th July, 9·57 hrs.—"Hoist warning signal ; storm, at present slight intensity, near Calingapatam moving slowly northerly direction."

31st July, 10·40 hrs.—"Storm probably intensifying, but still not severe; nearly stationary off Gopalpur."

1st August, 10·55 hrs.—"Depression intensifying, but still rather feeble and stationary off Gopalpur. Likely to cross coast south of False Point."

2nd August, 10·12 hrs.—"Lower warning signal; hoist danger signal No. 3 ; storm now of moderate intensity will probably cross coast near False Point."

3rd August, 10·50 hrs.—"Lower storm signal ; storm now inland near False Point ; but weather probably still stormy over north Bay."

In addition to the above action was taken at Rangoon (7), Puri (5), Chandballi (5), Balasore (5), Gopalpur (7), Calingapatam (7), Vizagapatam (7), Cocanada (7), Masulipatam (7), Madras (7), Calcutta and river stations.

(7) This storm was unimportant.

(8) „ „ „ „

(9) „ „ „ „

(10) „ „ „ „

(11) „ „ „ „

(12) The storm of the 3rd to 6th November formed off Ceylon on the 3rd, developed into a small, but severe, storm and crossed the coast near Nellore on the evening of the 6th. The following was the action taken with regard to Madras as representing the Coromandel coast :—

6th November, 10·35 hrs.—"Storm approaching coast between Nellore and Madras and quite close, possibly very severe, ports Gopalpur to Madras informed."

7th November, 10·26 hrs.—"Storm now inland ports Gopalpur to Madras informed."

In addition to the above, storm telegrams were sent to Rangoon (2), Gopalpur (2), Calingapatam (2), Vizagapatam (2), Cocanada (2), Masulipatam (2).

(13) The storm of the 11th to 14th November developed moderate intensity, and crossed the Arakan coast on the evening of the 14th. The following was the action taken with regard to Akyab representing the Arakan coast :—

12th November, 10·38 hrs.—"Disturbance unknown, intensity about lat. 16° long. 90°; moving some direction between north and north-west; may curve on to Arakan coast; watch weather, suggest warning signal."

13th November, 11·16 hrs.—"Depression moving towards Gopalpur, but is probably now of little importance; suggest lower warning signal."

14th November, 9·30 hrs.—"Suggest danger signal No. 3; eight o'clock observations show storm quite close to Akyab."

14th November, 15·14 hrs.—"Centre of storm at fourteen hours still moving towards Akyab and very close."

14th November, 20·47 hrs.—"Suggest lower storm signal; storm now inland.".

In addition to the above, storm telegrams were sent to Port Plair (2), Rangoon (5), Diamond Island (2), Chittagong (2), Madras (2), Cuddalore (2), Negapatam (2), Pamban (2), Tuticorin (2).

(14) The storm of the 22nd and 23rd November failed to develop, but the following action was taken with regard to Pamban as representing the Coromandel coast :—

21st November, 10 hrs.—"Weather suspicious southwest Bay, some disturbance probably approaching south Madras coast."

21st November, 22·15 hrs.—"Depression now appears to be approaching coast near Pamban. Suggest danger signal number three."

23rd November, 10·50 hrs.—"Depression now probably breaking up, though rough squally weather still reported near Pamban and off Ceylon; suggest lower storm signal."

In addition to the above storm telegrams were sent to Madras (3), Cuddalore (3), Negapatam (3), Tuticorin (3) and Colombo (4).

28. Comparing paragraph 27 with paragraph 26 the results show that for the storms on April 13th to 16th (1), May 18th to 20th (2), July 1st to 3rd (5), and July 27th to August 3rd (6), the warnings issued were in excellent time and the information supplied to the threatened ports was full and useful. On the other hand the amount of warning given in the case of the storm of November 3rd to 6th (12) was slightly brief; in the case of the storm of November 11th to 14th (13) some doubts existed as to the direction of movement of the disturbance and on the 13th it was supposed to be travelling towards Gopalpur and to be of little importance, so that it was suggested to lower the signal; while on the morning of the 14th the danger signal was suggested for Akyab and the storm crossed the Arakan coast on the evening of that day. As will be seen later the Port Officer, Akyab, acting on his own discretion, doubted the movement of the storm towards Gopalpur or its slightness, and disregarding the suggestion to lower the signal kept it flying. In the case of the storm of November 22nd and 23rd (14) an exaggerated view of its importance was taken and the danger signal was suggested at Pamban while as a matter of fact the storm failed to develop and disappeared on 24th.

29. The daily flag signal message was sent to Saugor Island throughout the year and to Elephant Point and Diamond Island from April 1st 1910 to January 14th 1911 only. This message was also sent to the Port Officer, Rangoon, during the period January 15th to March 31st.

Arrangements were made for the exhibition of the flag signals relating to the weather in the four sections of the Bay of Bengal, and of the storm signals on the extended system at Slipper Island. The flag signal message was sent to the Telegraph Master, Slipper Island, from 19th November 1910 to 14th January 1911. In future these messages will be sent from 1st April to 14th January each year.

The Port Officer, Akyab, having expressed a desire to be supplied with the flag signals in addition to the daily weather telegram, arrangements were made for their supply from 30th September 1910.

The following officers were supplied with the flag signals and the daily weather telegram from 1st April 1910 to 14th January 1911 :—

Port Officer, Rangoon.	Deputy Port Conservator, Madras.
Deputy Port Conservator, Rangoon.	Port Officer, Cuddalore.
Port Officer, Akyab.	Port Officer, Negapatam.
Port Officer, Cocanada.	Port Conservator, Porto Novo.

The following officers received the daily weather telegram only during the period mentioned above, *viz.*, from 1st April 1910 to 14th January 1911 :—

Port Officer, Moulmein.

Port Officer, Gopalpur.

Port Officer, Vizagapatam.

Port Conservator, Calingapatam (Sundays, Wednesdays and Thursdays only).

The Port Officer, Chittagong, received the daily weather telegram and the flag signal message from 16th May to 15th November.

30. *Arabian Sea Storm Signal Service.*—The work of warning the Arabian Sea ports was carried out during the past year by the Simla Meteorological Office, which also warned the Madras ports on the Malabar coast. Warnings of storms in the Arabian Sea were also sent to the Port Officer, Aden, for the information of steamers leaving that port. Copies of all warnings sent to the Malabar ports were forwarded for information to the Master Attendant, Colombo; the Meteorological Observatory, Colombo; the Commercial Agent to the Diwan of Alleppi; the Presidency Port Officer, Madras; the Deputy Port Conservator, Madras; and the Chief Engineer for Irrigation, Madras.

Warnings were also sent to the Diwan of Junagadh; the Superintendent of Telegraphs, Gujarat Division; the Agent to the Governor, Rajkot, and through the Commander of the Port, Mormugao, to the Portuguese Port of Diu.

The following is a list of the Arabian Sea and Malabar ports for the warning of which during the year 1910-11 the Simla Meteorological Office was responsible :—

I.—By extended system.	II.—By brief system.	
Karachi.	Cutch-Mandvi.	Murud Janjira.
Bombay.	Jamnagar.	Ratnagiri.
Mormugao.	Dwarka.	Harnai.
Mangalore.	Porbandar.	Mu'wan.
Tellicherry.	Veraval.	Goa.
Calicut.	Jafrabad.	Vengurla.
Cochin.	Bhavnagar.	Karwar.
	Daman.	Kumta.
	Alibag.	Honavar.

The approach of the monsoon was notified to the west coast ports as was done in the previous year.

31. The following gives a short statement of the storms which affected the Arabian Sea coasts during the year 1910-11 :—

(1) *June 3rd-4th 1910.*—There were indications of a cyclonic storm forming in the North of the Arabian Sea during the advance of the monsoon in June, and the warning signal was hoisted on the 3rd and 4th June at all ports from Karachi to Bombay, and at Mormugao. The low pressure conditions disappeared without developing into a storm.

(2) *August 20th to 22nd.*—A cyclonic storm from the Bay was crossing the Peninsula, and storm signals were hoisted on the Sind and Bombay coasts. The disturbance disappeared without passing out into the Arabian Sea, and all signals were lowered on the 22nd.

(3) *November 6th and 7th.*—At the beginning of November a depression from the Bay was travelling across the Peninsula, and as it appeared probable that the disturbance would pass out into the Arabian Sea storm signals were hoisted on the 6th and 7th at such ports as were likely to be affected. The depression on approaching the Konkan coast, however, changed its course and filled up over the land.

32. The following shows the action taken by the Simla Office in the case of the disturbances of the foregoing list :—

(1) The indications of a cyclonic storm in the north of the Arabian Sea between the 3rd and 4th led to the following action at Simla to warn Karachi :—

2nd June, 16·30 hrs.—"Monsoon apparently approaching Konkan coast, squally weather likely there."

3rd June, 23·20 hrs.—"Cyclonic storm probably formed about lat. 22° and long. 66°; moving northwards. Hoist warning signal."

4th June, 6·4 hrs.—"Little information yet available; there is certainly area low pressure and squally winds south of Karachi; but doubtful whether fully developed storm, doubtful whether port will experience strong winds, but vessels going out likely meet rough weather."

4th June, 8·10 hrs.—"Northward movement of disturbance apparently checked."

4th June, 11·25 hrs.—"Area of rough weather still to west of Kathiawar: No indication of movement towards Karachi, but caution necessary for vessels leaving port."

4th June, 16·20 hrs.—"Situation unchanged."

4th June, 22·50 hrs.—"Area of stormy weather no longer off Kathiawar coast; has almost certainly dissipated."

5th June, 5·30 hrs.—"Disturbance dissipated; lower signal."

(2) In regard to the cyclonic storm which in August threatened the Bombay and Sind coasts, the following was the action taken at Simla to warn the South Bombay coast :—

21st August, 11·45 hrs.—"Feeble cyclonic storm from Bay now crossing over Peninsula; centre near Bijapur; travelling west-north-west, may give squally weather: Hoist danger signal."

21st August, 21·10 hrs.—"Disturbance probably disappeared, will send definite information tomorrow."

22nd August, 10·40 hrs.—"Disturbance has disappeared: lower danger signal."

(3) For the cyclonic storm which in November threatened the Bombay coast, the following was the action taken at Simla to warn Ratnagiri as representing that coast :—

6th November, 22·45 hrs—"Storm now crossing coast at Nellore likely move westward; not likely give port violent winds, but may affect shipping between lats. 12° and 16°, in 24 hours."

7th November, 12·20 hrs.—"Storm now near Bellary likely cross coast near Goa to-night, and give rough weather from there southwards. Possible, but not probable, that your port will experience stormy weather; hoist warning signal."

7th November, 22·0 hrs.—"Storm now in Bombay Deccan of slight intensity, probably give squally weather on Konkan coast and become more severe when it has passed out to sea. Replace warning by danger signal."

8th November, 11·55 hrs.—"Disturbance now crossing north Konkan coast, but has weakened further and not likely give rough weather but may possibly develop out in Arabian Sea: Lower signal."

33. The two preceding paragraphs exhibit the difficulties which attend the work of warning the ports on the west coast of India. In the case of cyclonic storms forming over the Arabian Sea the only observations available for forming

a judgment are those from one limb only of the disturbed area, *viz.*, the coasts of Sind, Bombay and Malabar; and the difficulty of determining the distance and intensity of the supposed disturbance is obvious, while, in the case of storms traversing the Peninsula and threatening to redevelop in the Arabian Sea, it is at present almost impossible to say whether the attendant cyclonic circulation will break up during the passage of the Western Ghâts, or whether the storm will surmount this obstacle and pass out into the Sea area.

34. As regards the storm warning services generally, the Port Officers at the principal ports on both sides of India state that the system worked satisfactorily in every respect during the year and they suggest no change. The following extracts from some of their reports are interesting as exemplifying the success of the departmental warnings, in some regions, and the difficulties experienced in others.

The Principal Port Officer, Burma, Rangoon, in connection with the cyclone which passed over Akyab on the night of the 14th April 1910 (storm No. 1 of Bengal List), reports "that the Port Officer, Akyab, in his report to me of the damage caused by the cyclone states that the damage to the shipping in port would have been of a much more serious nature had not the Meteorological Department kept me so well informed of the approach of the cyclone, enabling me to tow all boats into a safe anchorage, and to issue notices to the merchants and vessels in the port to take all precautions necessary".

The Principal Port Officer adds "I feel sure you will be gratified to learn how much your storm warnings are appreciated, and with regard to Rangoon I can assure you that the progress of the storm and its intensity were indicated with great accuracy, and owing to this the damage done to small craft was inconsiderable".

The officer in charge of the service at Ratnagiri reports that out of the 116 telegrams received during the year at Ratnagiri, all were timely and satisfactory, except in the case of the "violent storm" on the Ratnagiri coast on the 30th September, the telegraphic intimation of which was received on the 1st of October.*

On the 13th November (storm No. 13 of Bengal List) a telegram was issued to the Port Officer, Akyab, among other officers, suggesting to him to lower the warning signal. In his report on the weather that officer said of this message "most misleading as weather here showed close proximity of cyclone; kept signal flying". On further enquiries being instituted the successor to the Port Officer wrote "these remarks were made by my predecessor and I can find nothing on record to justify them". See, however, the statement about these warnings in paragraph 28.

Flood warnings and weather forecasts to District, Irrigation, Railway and other Officers.

35. This work is carried out chiefly by the Simla Meteorological Office, but partly by that of Calcutta. The arrangements for it have been sanctioned at various times, and differ considerably in character, according to the nature and extent of the flood or weather warnings required by the officers concerned. In some cases these officers require telegrams warning them of advancing storms likely to give heavy rain, or of actual heavy rainfall, likely to give rise to severe floods which might injure railways or canal works; and in others they require warnings or forecasts of the weather for as long a period beforehand as possible, so as to enable them to modify their arrangements for carrying on the works under their charge so far as may be necessitated by sudden or large changes of weather.

The number of district officers and officers in the irrigation, railway and other departments requiring warnings from Simla amounted at the end of the year to 96, an increase of 1 during the year.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Karachi, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

The number of special warning messages sent from Simla during the year 1910-11 was 2,649, as compared with 941 in 1909-10 and 1,199 in the year before.

---

* An area of low pressure lay to the north of Ratnagiri on the 30th September, and was causing winds of force 6 or 7 in the vicinity of that part, but the available marine information shows that there was no storm at sea. A message was sent to Ratnagiri at 22·20 hrs. on September 30th as follows :—"Depression over south Gujarat giving strong winds off Bombay coast."

Warnings of floods or of heavy rainfall were issued by the Meteorologist, Calcutta, to officers of the Public Works, Telegraphs and other Departments, chiefly in Bengal and on the East Coast.

Instructions were issued nine years ago by the Government of India that every officer to whom storm or flood warnings are issued, should in the month of January of each year or in the case of military expeditions at the close of the campaign, forward to the head of this department a brief return of the warnings received during the past year and should also report :—

(1) Whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

(2) Whether the warnings were timely and satisfactory in every respect, and, if not, in what points they were defective.

(3) Whether any changes might be made in the system which would make the warnings more useful.

Reports on the storm and flood warnings for the calendar year 1910 were received from 59 officers. Of these 50 reported that the warnings were timely and satisfactory and were rapidly transmitted by the Telegraph Department; 4 offered no remarks and 5 officers, of whom, however, only one was on the warning list, reported that they had received no warnings during the year.

A comparison of the reports of floods and of heavy rain with the information supplied to the various officers would appear to show that the system is working satisfactorily, and that most of the warnings issued were timely and of use to the recipients. No suggestions were put forward by the officers concerned for changes or improvements in the flood warning service.

Seasonal Forecasts.

36. The forecast for the monsoon period of 1910, dated the 9th June, was sent to Local Governments and Administrations, communicated to the press and printed in the Gazette. A statement of the rainfall of June and July with a forecast for August and September was drawn up on the 6th August and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was drawn up on the 23rd December 1910 and sent to Local Governments and Administrations.

The following shows the points of these two forecasts, and gives a comparison of them with the actual rainfall :—

Forecast.	Remarks.
(1) There appears to be no cause for expecting a large excess or defect in the total amount of monsoon rainfall.	Verified. The excess of the total monsoon rainfall, averaged over India, was 1·7 inches, or 5 per cent.
(2) The rains are likely to be less steady than usual, especially those due to the Arabian Sea current, and periods of marked weakness are likely to alternate with bursts of abundant rainfall.	Verified.
(3) Rainfall due to the Bay current is likely to be on the whole more plentiful, by comparison with the normal, than that due to the Arabian Sea current.	Incorrect : the Arabian Sea current was appreciably more active than the Bay current.

MEMORANDUM OF THE 6TH AUGUST 1910.

Forecast.	Remarks.
(*a*) The general outlook appears more uncertain than usual, but there is no reason for expecting a large defect in the total amount of rainfall during August and September.	The total rainfall during August and September was in excess by 2½ inches.
(*b*) The unsteadiness in the monsoon, especially in that of the Arabian Sea, is likely to persist, and there will probably be marked breaks as well as periods of plentiful rainfall.	Verified.
(*c*) The quantity of snow on the hills is not sufficient to exert any prejudicial influence upon the rainfall of northwest India.	Verified. The rainfall of northwest India during August and September was in decided excess.
(*d*) The weakness of the Bay current is likely to continue, and there is no cause for anticipating an early large improvement in the rainfall of the Gangetic plain.	Only partially verified. The Bay current continued weak except in Burma : but a considerable improvement occurred in the Gangetic plain about the middle of August, owing chiefly to an unusual northerly extension of the Arabian Sea current.

A memorandum on the weather during November and December 1910, with a forecast of that of January and February 1911, was prepared on the 2nd January and issued in the same manner as the forecast of the previous June. On the 12th July 1911 a comparison of the actual precipitation with the above forecast was issued : the forecast and actual conditions are shown in the following statement :—

Forecast.	Remarks.
The indications are somewhat conflicting, but it appears likely that the rainfall in the plains of northwest India will be in moderate defect or normal, and that the precipitation in the surrounding mountain districts will be normal or in moderate excess.	The evidence now available is not in agreement with the former of these anticipations, and in regard to the latter, actual snowfall proved to be in somewhat greater excess than was indicated.

DAILY TELEGRAPHIC WEATHER SUMMARY.

37. The summary was despatched daily at about noon.

It was exhibited at certain telegraph offices, and sent to 86 officers of Government. The number of subscribers was as follows :—

Subscribers.	Number during monsoon period of 1910.	Number on 31st March 1911.
Newspapers	7	8
Private individuals	32	4

PUBLICATIONS.

A.—WEATHER REPORTS.

38. *India Weather Reports.*—The following weather reports, giving information of the current weather to the Government and the public, were published during the year by the Simla Meteorological Office :—

(1) India Daily Weather Report.

(2) India Weekly Weather Report, giving an account of the weather and of the rainfall of the week ending on the previous Thursday, published in the *Gazette of India* every Saturday.

(3) Monthly Supplement to the India Daily Weather Report, published in the first week of the succeeding month.

(4) Annual Supplement to the Daily Weather Report.

(5) India Monthly Weather Review, giving a general summary of all the important features of the weather, and complete meteorological data of the month ; the data for this are not at once available and it is usually published three months after date.

(6) Annual Summary of the Monthly Weather Reviews.

For a detailed description of the contents of these publications reference may be made to the Departmental Administration Report for 1907-08.

India Daily Weather Report.—The number of stations for which data were given in the daily report of the 31st of March 1911 was 178. The following table shows the distribution of the reports :—

	Number of recipients on the 31st March.				
	1911.	1910.	1909.	1907.	1905.
Government Officers ...	516	514	509	442	408
Foreign recipients ...	47	45	46	46	46
Newspapers ...	2	2	2	2	2
Subscribers	19	17	18	11	12
Total ...	584	578	575	501	468

39. *Annual Summary.*—The annual summary of the meteorology of India for 1909 supplementing the Monthly Weather Reviews for that year, was issued in December 1910. It contains mean data for the year, and a discussion of its more important meteorological features together with their mutual relations. A summary of the meteorology of the year 1909 was also prepared for the Sanitary Commissioner with the Government of India, and was given as Chapter I of the Annual Report of that officer for the year.

40. *Special Charts.*—The Simla Office prepared, throughout the year, weekly charts showing the character of the rainfall of each week and of the seasonal rainfall up to date, for the use of His Excellency the Viceroy, His Majesty's Under Secretary of State for India, London, the Hon'ble the Finance Member and the Secretary to the Government of India in the Revenue and Agricultural Department.

41. *Provincial Weather Reports.*—The following provincial reports were issued by the local meteorologists during the year :—

(1) Calcutta—

(*a*) Daily Weather Report.

(*b*) The supplementary weekly meteorological and rainfall table containing temperature and rainfall observations recorded at 19 stations in Bengal and in Eastern Bengal and Assam, issued to all subscribers of the Weather Report on every Wednesday throughout the year.

(2) Bombay—

(*a*) Daily Weather Report.

(*b*) Monthly abstracts of meteorological observations published in the Bombay Government *Gazette*.

(3) Madras—

(*a*) Daily Weather Report.

(*b*) Monthly Rainfall Tables for Madras, Coorg, Pudukkottai, Cochin and Travancore, published in the Provincial *Gazette*.

(4) Allahabad—

(*a*) Monthly Weather Summary of the United Provinces published in the Provincial *Gazette*.

(*b*) Brief sketch of the meteorology of the United Provinces for the year 1909.

(*c*) Monthly Rainfall Tables for the United Provinces published in the Provincial *Gazette*.

(5) Simla—

(*a*) Monthly Summary of the weather of the Punjab, published in the Provincial *Gazette*.

(*b*) Annual Meteorological Summary of the Punjab for the year 1909-10.

42. *Memoirs of the Indian Meteorological Department.*—The following were published during the year 1910-11 :—

(1) On the electricity of rain and its origin in thunderstorms by George C. Simpson, D.Sc., Imperial Meteorologist. (Memoirs of the Indian Meteorological Department, Volume XX, Part VIII.)

(2) Correlation in seasonal variations of weather, II, by Gilbert T. Walker, M.A., Sc. D., F.R S., Director General of Observatories. (Memoirs of the Indian Meteorological Department, Volume XXI, Part II.)

Supply of meteorological information.

43. In addition to the meteorological information published by the department the following special information was supplied to other meteorological institutions:—

(*a*) Weekly telegrams containing weekly pressure departures from normal of Bombay, Seychelles, Zanzibar and Aden were sent to the Director General, Survey Department, Cairo, during the monsoon period.

(*b*) Monthly telegrams were sent to the Meteorological Office, London, during the monsoon period giving information of the state of the Arabian Sea and Bay of Bengal for insertion in their monthly pilot charts.

(*c*) Monthly telegrams were sent to the Solar Physics Committee, London, throughout the year giving the mean monthly pressure of Bombay.

(*d*) Monthly telegrams were sent to the Meteorological Department, Melbourne, Australia, throughout the year giving the monthly mean pressure and temperature departures from normal of India, and a short description of the general conditions of weather.

(*e*) Weekly code telegrams were sent during the monsoon period from Simla to the Calcutta Meteorological Office for drawing up a table of rainfall, humidity and temperature at 100 representative stations in India, to be published by the Director General of Commercial Intelligence in the *Indian Trade Journal*.

Climatological information, at times involving special calculation, is also provided for sanitary and other officers of Government, as well as for private firms who are willing to pay the expense necessarily incurred . The extent to which the Department is utilised in this manner is increasing steadily.

MISCELLANEOUS.

44. Nine hundred and fifteen books and pamphlets, either purchased or presented by scientific bodies, were added to the Library during the year. The Library is on the whole in fair order.

Nineteen libraries, observatories or societies were added during the year to the list of institutions to which the publications of the India Meteorological Department are supplied, and five were removed; the number on the list is now 398.

CHIEF FEATURES OF THE YEAR.

45. The work of the department falls naturally into two parts, (1) the directly useful and (2) the scientific, which aims at ascertaining facts which shall be of practical usefulness in the near future. The former part consists chiefly of the collection and distribution of current weather information, the supply of climatological data, the issue of storm and flood warnings and the provision of time signals. The scientific work includes the experimental and theoretical examination of the physical processes, on the earth or the sun, which determine the weather.

The number of storms over the Indian seas was not exceptional during the year under review, and in the Arabian Sea no storm of importance was recorded. Information regarding the storms, the success of the warnings issued and remarks on the usefulness of the storm signal service have been given in paragraphs 25 to 34. In the Bay of Bengal the most important storm was that which crossed the coast near Akyab on the morning of April 16th. Although most of the storms were of only slight or moderate intensity, the work of issuing warnings was as usual heavy and difficult.

The work of issuing predictions of heavy rain to officers requiring them, or information of unusual precipitation which has actually occurred, has been placed on a satisfactory basis, and has in general been carried out with as much success as can reasonably be expected. Owing to the general heaviness of the monsoon the number of special warning messages sent from Simla increased largely, the numbers being 1,199 in 1908-09, 941 in 1909-10 and 2,649 in 1910-11.

A conspicuous feature of the work of the department has been the continuous growth of the departmental correspondence. Requests for information, in general of a statistical character, have come in numbers from officers interested in the relations of weather and disease, of weather and agriculture, etc., as well as from firms wishing to start factories under special conditions; while enquiries about meteorological subjects—books, instruments and methods of observation—have been very numerous. The amount of work involved has been very considerable.

On the scientific side work has been much hampered by the weakness of the gazetted staff. Dr. Simpson has been absent with the South Polar Expedition throughout the whole year and his experiments in the electrification of the atmosphere, his observations with the Benndorf self-registering electrometer naturally came to an end, as Mr. W. A. Harwood who was appointed to act for Dr. Simpson from the 15th of April was wholly new to the work of the Department and had to spend his time on routine duties.

In addition, Mr. J. Patterson, who was appointed to the Department in 1905, resigned his post on the 6th of May, and the vacancy caused by this resignation was not filled up. On the other hand some progress has continued to be made in the examination of the conditions in the upper air, and India is following in the wake, though very far in the wake, of other civilised countries in conducting observations with balloons to sound the depth and hygrometric character of the monsoon and other air currents on which the Indian weather depends.

At Kodaikanal Mr. Evershed has continued his spectroscopic, photographic and instrumental examination of the sun and its atmosphere. The staff at Kodaikanal has been changed by the retirement of the Director, Mr. Michie-Smith, and the appointment on the 28th of February of Mr. T. Royds as Assistant Director.

The memoirs of the Department have been added to by two valuable papers, *viz.*, that "On the electricity of rain and its origin in thunderstorms" by Dr. Simpson and by a paper on "Correlation in seasonal variations of weather", part II, by Dr. Walker, the latter being an important contribution towards the question of forecasting future weather conditions.

Concluding remarks.

46. The Meteorological Department owes a large part of its usefulness, its activities, and its progress to the sympathetic assistance it receives from outside departments. Civil Surgeons and other officers of the Medical Department, as unpaid superintendents of observatories and in other capacities, help in the daily record of meteorological work; the Telegraph and Postal departments assist in every way in the rapid transmission of meteorological information, at the same time that they allow their employees to act as observers. The Eastern Telegraph Department, by transmitting the daily Aden message free, and the Indo-European Telegraph Company by giving free transit to the daily records of the Persian observatories, place a large volume of most valuable information at the disposal of the Meteorological Department.

Weekly telegrams were received from the 1st May to the 15th October from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams gave valuable information of the weather conditions in the Indian Ocean and the Department is indebted to the officers indicated for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the India Meteorological Department.

The Department is greatly indebted for important information as to meteorological conditions prevailing antecedent to and during the south-west monsoon, to the Director of the Government Observatory, Durban; the Director, Agriculture and Forestry Department, Zomba, British Central Africa; the Meteorologist, Dar-es-Salaam; His Majesty's Commissioner, Entebbe, Uganda; the Director General, Survey Department, Cairo; the Commonwealth Meteorologist, Melbourne; the Directors of the Observatories at Buenos Ayres and Santiago; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

The Central office of the Meteorological Department, at Simla, was under the charge of Dr. Walker throughout the year under review and the general administration of the Department was in his hands while the local officers who have helped very materially with the current work of the Department were as follows:—Calcutta, Mr. C. W. Peake; Madras, Mr. R. Ll. Jones; Bombay, Mr. H. A. Armstrong; and Allahabad, Dr. E. G. Hill and Mr. J. J. Durrack.

J. H. FIELD,
Offg. *Director General of Observatories.*

Simla, the 28th October 1911.

G. C. B. P., Simla.—No. 268 M. R. G. I.—18-11-11.—286—D. D.

REPORT

ON

THE ADMINISTRATION

OF

THE METEOROLOGICAL DEPARTMENT

OF

THE GOVERNMENT OF INIDA

IN

1912-13.

CHANGES IN THE STAFF DURING THE YEAR.

Dr. Gilbert T. Walker resumed charge of the office of Director-General on the 21st April 1912 on the termination of combined leave to Europe.

Mr. J. H. Field proceeded on privilege leave for three months from 31st August 1912 to 30th November 1912 combined with furlough for one year and nine months from 1st December 1912.

Dr. George C. Simpson returned from the British Antarctic Expedition on 24th August 1912.

Mr. W. A. Harwood was on three months' privilege leave from 15th January 1913 to 14th April 1913.

Mr. C. W. Peake was on special duty at Dacca from 17th July 1912 to 19th August 1912, and on privilege leave from 27th September 1912 to 28th October 1912. Dr. E. P. Harrison acted.

Mr. H. A. Armstrong proceeded on three months' privilege leave combined with 18 months' furlough from 5th February 1913. Mr. G. W. Talbot acted.

Dr. E. G. Hill was on leave during the College vacation from 25th April 1912 to 20th July 1912. Dr. A. P. Sircar acted.

OBSERVATORIES.

2. The observatories maintained by the Government of India are classified as follows :—

First Class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, and wind direction and velocity, in addition to instruments read by eye.

Second Class.—Observatories at which readings are taken daily at 8 hrs., 10 hrs., and 16 hrs. : those at 8 hrs. are (with a few exceptions) transmitted by telegram to one or more of the offices at Simla, Calcutta, Bombay and Madras for inclusion in the India or Provincial Daily Weather Reports.

Third Class.—Observatories—

(*a*) where readings are taken daily at 8 hrs. only; at those stations where there are telegraph offices the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports;

(*b*) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determination of monthly and daily means which should be comparable with the means already obtained for second class observatories.

Fourth Class.—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only, are recorded.

Fifth Class.—Observatories which telegraph rainfall only.

3. At the end of the year the total number of observatories was 283, of which 48 were non-departmental and 235 were maintained by the Government of India. Of the 235 departmental observatories, 7 were first class, 4 second class, 181 third class, 23 fourth class and 20 fifth class.

4. The changes in non-departmental observatories during the year were the following:—

(1) A fourth class observatory was opened at Lumding on 1st April 1912 under the superintendence of the Medical Officer, Assam Bengal Railway, and a fifth class observatory was opened at Khanpur on 25th February 1913.

(2) The following observatories were closed:—

(*a*) The third class observatory at Chitral on 1st August 1912.

(*b*) The fourth class observatory at Ballia on 1st January 1913.

(3) The third class observatory at Drosh was changed from non-departmental to departmental on 6th August 1912.

(4) The third class observatory at Cooch Behar was changed to fifth class on 1st April 1912.

The following were the changes in departmental observatories during the year:—

(1) Third class observatories were opened at Fort Sandeman on 1st April 1912 and at Hukitala on 18th September 1912.

(2) A fifth class observatory was opened at Asansol on 1st February 1913.

(3) The observatory at Simla was reduced from second to third class on 1st January 1913.

(4) The following observatories were reduced from third to fifth class on 1st April 1912:—Arrah, Bankura, Bhagalpur, Chapra, Comilla, Dehri, Faridpur, Hazaribagh, Krishnagar, Malda, Motihari, Muzaffarpur, Rampur Boalia, Rangpur, Raniganj, Sirajganj and Tinnevelly.

(5) The third class observatory at False Point and the fifth class observatory at Raniganj were closed on 18th September 1912 and 1st February 1913 respectively.

First Class Observatories.

5. The Directors of the Observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded for the information of Government. It has accordingly been ruled as unnecessary to include information relating to the working of these observatories in this Administration Report.

6. At Alipore (Calcutta), Allahabad and Lahore the following special instruments were in use during the year:—

Alipore.	Allahabad.	Lahore.
Bergholz barograph.	Beckley anemograph.	Draper barograph.
Kew barograph.	Richard barograph.	Richard barograph.
Kew thermograph.	Richard thermograph.	Casella rain-gauge.
Richard thermograph.	Stokes sunshine recorder.	Beckley anemograph.
Beckley anemograph.	Solar radiation thermometers.	Sunshine recorder.
Dines' pressure tube anemometer.	Grass thermometer.	Grass thermometer.
Beckley rain-gauge.	Ground thermometer.	Nephoscope.
Monthly rain-gauge.	Nephoscope.	
Hellman Fuess rain-gauge.		
Milne seismograph.		
Grass thermometer.		
Ground thermometer.		
Nephoscope.		

7. *The Alipore Observatory.*—This observatory is under the charge of the Meteorologist, Calcutta.

The autographic instruments have on the whole worked satisfactorily during the past year.

All instruments issued by the Meteorological Department are tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 1,207 as compared with 771 last year. 206 instruments were condemned as unfit for issue, or were sent to the India Office for repair and 11 instruments were kept in store for future treatment. In addition to the above, 227 instruments were examined and issued to other observatories.

The observatory gives mean Calcutta time to the port and shipping. Three time balls are dropped daily at 1 P.M. local mean time throughout the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore Docks.

This work was carried out quite satisfactorily as far as this department is concerned. There were 50 failures as compared with 15, the average number of the past 24 years ; but in all cases they were due to defects in the electric or mechanical arrangements outside the observatory, for which this department is not responsible.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1912-1913	50	50
1911-1912	21	21
1910-1911	21	20
1909-1910	28	27
1908-1909	18	18

8. *The Allahabad Observatory.*—This observatory is under the charge of the Meteorologist, Allahabad.

Beckley anemograph.—This instrument did not work so well during the past year; there were short breaks on twenty occasions caused either by the instrument being out of order or the clock stopping.

Richard barograph.—This instrument gave excellent tracings throughout the year. All the charts have been tabulated.

Richard thermograph.—The wet bulb tracings of the thermograph have again not been very good, but the dry bulb tracings, with a few exceptions, have been satisfactory.

Sunshine recorder.—This gave good results without a break.

Nephoscope.—Regular observations have been made with the Duboscq instrument.

Readings of all the eye instruments were taken every two hours from 6 hrs. to 22 hrs. The earth thermometer on the surface was read at 6, 14 and 22 hours up to 5th December 1912 and only at 14 hours thereafter.

9. *The Lahore Observatory.*—Eye observations of the ordinary meteorological instruments were taken seven times daily at this observatory as in past years at 6, 8, 10, 14, 16, 18 and 22 hrs. Ground surface temperature was recorded four times daily at 6, 10, 16 and 22 hrs.

CHARACTER OF THE WORK OF OBSERVATION AT SECOND AND THIRD CLASS OBSERVATORIES.

10. The general character of the work of the observatories, as judged by the number of mistakes made by observers was satisfactory.

The number of stations of great reliability, in which either no mistake or only one mistake has been detected in the data for the Indian Daily Weather Report, was 45 as against 32 in 1911-12; while, the number of stations at which more than 50 mistakes were made was 18 as against 14 last year.

The usual list showing the number of mistakes in observation and in the preparation of telegrams for all the observatories which send weather telegrams to the Simla office was prepared and circulated to the observatories on the 21st June 1913.

INSPECTION OF OBSERVATORIES.

11. The number of visits paid to observatories during the year under review was 51 as compared with 37 in the previous year and an average of 64 during the past 10 years.

The Director-General inspected the observatories at Calcutta, Bombay, Alibag, Madras, Kodaikanal and 5 third class observatories in Burma; Mr. Hem Raj inspected 11; Mr. Bion 7; Mr. Gaetane 17; Mr. Subrahmanyam 6; Mr. C. Chengalvaraya Mudeliar 4; and the Chief Observer, Allahabad 1.

Of the 51 observatories that were visited 31 were reported as good, 17 as tolerable and 3 as bad.

Condition.	Number of Observatories Inspected in					
	1912-13.	1911-12.	1910-11.	1909-10.	1908-09.	1907-08.
Good or satisfactory ...	31	20	23	25	40	43
Tolerable	17	16	31	11	20	18
Bad	3	1	3	4	2	10
Total ...	51	37	57	40	62	71

In estimating the general character of the observatories from the above table it must be remembered that it is, as a rule, on account of something unsatisfactory that a visit of inspection is made. The general level of the stations is thus decidedly better than might otherwise appear. The most frequent cause of bad work is the changing of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments.

Special Observations.

12. Observations other than those recorded by local observers at regular intervals are made as follows:—

(*a*) In accordance with orders issued from the Simla or Calcutta office, when weather is disturbed and storm warnings may have to be issued: such observations are sent by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Re. 1 for each set of special observations sent under instructions from either Simla or Calcutta. The number of telegrams of the latter class forwarded during the year under review was 607, as compared with 796 despatched the previous year.

(*b*) Certain observers, when they consider that conditions at sea are sufficiently threatening, send of their own initiative to Simla or Calcutta a telegram containing special observations. No occasion of this type occurred.

(*c*) In connection with flood warning a number of observers have been instructed to send telegrams announcing the occurrence of heavy rainfall to Government officers and railway engineers who desire early information. The number of telegrams so sent was 159 as compared with 135 last year.

(*d*) Observers are instructed to send detailed information of earthquakes to the Simla Meteorological office and to the Director, Geological Survey, Calcutta: for this work they are paid awards from this department. 182 reports were received during the year.

Observations with special Meteorological Instruments.

13. The following special observations were carried out during the past year at certain selected stations:—

1st.—Wind observations recorded by Beckley anemographs at 11 stations, and by Dines' pressure tube anemometers at 4 stations.

2nd.—Solar and terrestrial radiation observations at 3 and 11 stations, respectively.

3rd.—Underground temperature observations at 2 stations.

4th.—Sunshine observations at 7 stations.

5th.—Barometric observations recorded by self-registering instruments, chiefly Richard barographs, at 18 stations.

6th.—Temperature observations recorded by self-registering instruments, chiefly Richard thermographs, at 11 stations.

Observations of solar energy in absolute units.

14. Observations were continued at Simla throughout the year, when weather conditions allowed, by means of Angstrom's electric pyrheliometer.

Observations in the upper air.

15. At the instance of the Royal Society, this branch of scientific research has received a fresh impulse, and the hope is now entertained that more will be accomplished in this direction in the near future than has been possible in the past. Sanction has been given for a scheme under which Mr. J. H. Field (with the assistance of Mr. W. A. Harwood) will embark on a series of investigations which is calculated to extend over a period of ten years. The headquarters of the

work will be at Agra, where it is proposed to send balloons fitted with recording apparatus about twice weekly to as great a height as can be reached; and there will probably be four or five sub-stations from which, as well as from Agra, balloons carrying apparatus will be sent up several times a week to more moderate heights, say to about 12,000 feet. Pending the construction of the necessary buildings at Agra, activity in upper air research must necessarily be restricted to the reduction and discussion of data previously collected and to work with pilot balloons.

Researches by the Simla Staff.

16. Owing to Mr. J. H. Field's absence in England and the consequent pressure of administration, no systematic research work has been possible. Perhaps the most important memoir published was that giving information regarding the extent to which different parts of India are liable to heavy rain.

Seismograph Observations.

17. Seismological observations were recorded by two Omori-Ewing seismographs at Simla and one at Bombay; by Milne seismographs at Alipore (Calcutta), Kodaikanal and Colaba (Bombay); and by means of other self-registering instruments at the last named station. All the instruments worked satisfactorily throughout the year, and copies of the records of the Milne's seismographs were transmitted to the Seismological Committee of the British Association.

Marine Meteorology.

18. No change was made during the year under review in the method of collecting marine information.

At Calcutta and Bombay a clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard, for the purpose of applying the necessary corrections to the readings in the logs; and, after the barometer comparisons have been made a statement of the error of the ship's barometer is given to the captain, in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port, but it is ample for the purposes of the department.

The data thus obtained are utilised in the preparation of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department, and in drawing up an account of the storms of the year for publication in the Annual Summary.

The arrangements made with the London Meteorological Office, the Royal Alfred Observatory at Mauritius, and the Deutsche Seewarte, Hamburg, for collecting marine data from the whole of the Indian Ocean, have been continued and the thanks of this department are again due to these three offices for thus supplying a large amount of useful data.

Observations recorded during the year at the entrance of the River Hughli were supplied to the Meteorological Department by the light-vessels "Comet" and "Luna."

Snowfall Registration in the Mountain Districts to the North and West of India.

19. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete, and the thanks of the department are again due to the various officers who have collected and forwarded it. Additions to the information received have been obtained by continuing the series of large-scale photographs of the snows, as seen from Simla, which was started in 1905.

Rainfall Registration.

20. The registration of rainfall in India has invariably been carried out by the provincial authorities. In 1889 a uniform system was introduced by the Government of India, and the Director-General of Observatories was made consulting officer in connection with this work. His advice is sought regarding the starting of new rain-gauge stations, and he receives annual reports from the local officers responsible for the registration of rainfall upon

the efficiency of the work. A general account of the system, which came into operation in the year 1891-92, will be found on pages 5-8 of the Administration Report of the year 1889-90, and on pages 6 and 7 of the Administration Report for the year 1890-91.

The following is a statement of the number of rain-gauge stations from which data were being received for publication in the Rainfall Data of India at the end of the year under review :—

Province or Division.	Number of rain gauges supplying returns for publication on 31st March 1913.	Province or Division.	Number of rain gauges supplying returns for publication on 31st March 1913.
Burma	200	Baluchistan	90
Assam	124	Rajputana	185
Bengal	225	Bombay and Sind	289
Bihar and Orissa	258	Central India	117
United Provinces	276	Central Provinces	174
Punjab...	188	Hyderabad	22
Kashmir	37	Mysore	77
North-West Frontier Province ...	33	Madras (including Pudukkottai, Coorg, Travancore and Cochin).	501

The following paragraphs give a brief summary of the reports of the officers in charge of rainfall registration for the year 1912-13 :—

Assam.—The system of registration remained the same as in the preceding year. The total number of rainfall stations was 124, or one more than last year. The number of gauges inspected was 62 as compared with 72 inspected during 1911-12. The gauges in Cachar and the Khasi and Jaintia Hills were not inspected at all. Ten stations were inspected more than once.

Baluchistan.—No report has been received.

Bihar and Orissa.—There are 257 rainfall stations in this Province : only 34 inspection reports in the prescribed form were received in the course of the year ending 31st March 1913, but the Local Government is addressing Districts Officers on the subject of submitting more regular reports of inspections in future.

Bengal.—The number of stations on 31st March 1913 was the same as last year, namely 225 ; and of these 60 were inspected as compared with 108 inspected last year.

Berar.—The number of rain-gauges maintained during the year was the same as last year (44), and the number of inspections was 142 against 150 in the previous year. Only two rain-gauges were not inspected.

Bombay and Sind.—One new station was added last year making a total of 276 out of which 209 stations were inspected as compared with 190 last year. 78 gauges were inspected more than once and the total number of inspections amounted to 299 as against 288 inspected last year. Sufficient attention seems not to have been paid to this work in 4 districts in the Deccan, 1 in the Karnatak, 2 in the Konkan and 3 in Sind, and the attention of the collectors concerned is being invited to this point.

The improvement noticed last year in Native States was not quite maintained during the year under review. 41 gauges as against 44 were inspected out of a total of 61. 4 gauges were inspected more than once and the total number of inspections amounted to 47.

Burma.—The total number of rain recording stations in the Province is 200 as against 198 at the close of last year. Of these 19 are meteorological observatories and 26 are under the Public Works Department. The number of raingauges inspected was 154, or 21 more than last year, and of these 111 are reported in good condition, 43 being in a fair state.

Central Provinces.—The number of raingauges maintained during the year was 111 against 109 in the previous year. The number of inspections of which reports were received was 133 against 104 in the preceding year. The raingauges at 4 stations were not inspected. The results during the year were on the whole satisfactory.

Central India.—No report has been received.

Hyderabad.—In addition to two raingauges maintained by the Resident, there are 17 rainfall stations maintained by the Public Works Department which are all reported as efficient. There are also three raingauge stations maintained by the railway and revenue authorities.

Kashmir.—Out of the 36 rain-recording stations in the state, 8 are meteorological observatories and the remainder are in charge of the Revenue Department. Only 10 stations were inspected during the year. The attention of the local officials is being drawn to the necessity for having the raingauges inspected at least once in the year.

Madras.—On the 31st March 1913 there were 471 rain-recording stations (excluding the meteorological observatories) or one more than last year. Of these 390 are in the Madras Presidency and 380 were inspected as compared with 381 inspected last year.

Mysore.—At the close of the calendar year 1912 there were 220 raingauge stations as against 219 in the previous year. Out of these 188 or 85 per cent were inspected as compared with a percentage of 88 last year. The gauges were, on the whole, maintained in a satisfactory condition.

North-West Frontier Province.—The report on rainfall registration contained in the current administration report of the North-West Frontier Province refers to the year 1911-1912 and states that the raingauges and rainfall registers were in good order and properly maintained. There was no change in the numbers or situation of the raingauges.

Punjab.—The total number of raingauges in the Punjab during the calendar year ending December 1912 is 209 or one more than last year. Of these, 152 are in charge of District Officers and 57 under Canal Officers. There were 47 inspections by Revenue Officers as against 56 last year. No inspections were made in the districts of Rohtak, Karnal, Jhelum and Multan. On the whole, the gauges have been in good order and the records well kept up.

Rajputana and Ajmer-Merwara.—During the triennial period ending 31st March 1913 there were 416 raingauges as compared with 369 during the year ending 1909-1910. Most of the gauges were inspected during the period under review. Out of 22 gauges in State Dispensaries in Jaipur 5 were not inspected; out of 26 gauges in tahsils and thikanas in Jajpur none were inspected; out of 12 in Bharatpur 1 was not inspected; out of 14 in Dholpur 8 were not inspected; and out of 19 in Alwar 5 were not inspected.

United Provinces.—There were 286 rain-reporting stations in these Provinces including the Meteorological observatories. Out of the 272 stations in charge of District and Canal Officers 189, *i.e.*, 69 per cent, were inspected during the year.

Summary.—It will be seen that in Berar, the Central Provinces, and the Madras Presidency inspection is well carried out and over 95 per cent of the rainfall stations were visited; while the conditions in Mysore approach these, with 85 per cent of stations visited. This inspection is fairly efficient in Bombay and Burma, with about three-fourths of the raingauges inspected, and in the United Provinces with two-thirds. But in Assam the proportion is only 50 per cent, in Bengal 27 per cent and in Kashmir 28 per cent; while in Rajputana even in three years only about half the stations have been visited. In these four areas it can scarcely be expected that the rainfall return should be as reliable as is wanted for administrative as well as scientific purposes.

The System for Storm Warning.

21. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed from the Simla Office by the Director-General of Observatories, and from the Calcutta Office by the Meteorologist, Calcutta.

The following ports are warned from Simla for storms in the Arabian Sea:—

Aden, Karachi, Cutch Mandvi, Jamnagar, Dwarka, Porbandar, Veraval, Jafarabad, Bhavnagar, Daman, Bombay, Alibagh, Murud Janjira, Harnai, Ratnagiri, Malvan, Vengurla,

Nova Goa, Mormugao, Karwar, Kumta, Honavar, Mangalore, Tellicherry, Calicut, Cochin Alleppy and Colombo.

The Meteorologist, Calcutta, warns the following ports for storms in the Bay of Bengal:—

Colombo, Tuticorin, Pamban, Negapatam, Cuddalore, Madras, Masulipatam, Cocanada, Vizagapatam, Calingapatam, Gopalpur, Puri, False Point, Chandbali, Balasore, Saugor Island Diamond Harbour, Mud Point, Budge Budge, Calcutta, Morelganj, Barisal, Goalundo, Narayanganj, Noakhali, Chittagong, Cox's Bazar, Akyab, Diamond Island, Bassein, Rangoon, Moulmein, Tavoy, Mergui, Table Island and Port Blair.

22. In addition to special messages sent during stormy weather the Meteorologist, Calcutta, provides shipping during a large part of the year with daily information regarding the weather over the Bay. This information is made available at the following places by means of daily weather telegrams to an officer at the Port or by the hoisting of flag signals:— Negapatam, Porto Novo, Cuddalore, Madras, Cocanada, Vizagapatam, Calingapatam, Gopalpur, Saugor Island, Sandheads, Chittagong, Akyab, Diamond Island, Elephant Point, Rangoon, Moulmein, Kalagauk and Table Island.

23. In accordance with resolutions passed at the International Radio-Telegraph Conference held in London in June and July 1912, the Indian radio telegraph coast stations are now supplied with telegrams containing meteorological information with regard to the Arabian Sea and the Bay of Bengal for transmission to ships which ask for them. These messages have been sent to the radio stations at Bombay and Karachi from the 10th December and to those at Calcutta, Diamond Island, Table Island and Victoria Point from the 2nd January.

Arrangements are also being made for the receipt by wireless telegraphy of meteorological observations from ships at sea.

WARNINGS FOR STORMS IN THE BAY OF BENGAL.

24. During the year warnings were issued for sixteen disturbances. None of these however, developed into severe storms and only two of them were of sufficient importance for a statement to be given here of their course and of the action taken:—

(1) Weather was slightly disturbed in the north of the Bay from the 1st September, and the 8 hrs. observations on the 5th showed a well formed depression over the Sandheads. It moved somewhat rapidly and crossed the coast between Saugor Island and Balasore the same evening.

At Saugor Island, Calcutta and the other ports on the Hughli warning signal number six, indicating a storm of small extent that would probably cross the coast between Chittagong and False Point, was hoisted at about 10·15 hrs. on the morning of the 4th September, and was replaced by warning signal number eight indicating that the storm would probably cross between Saugor Island and False Point, at about 9·40 hrs. on the morning of the 5th. The signal was lowered at about 22·15 hrs the same evening.

(2) A depression was shown on the morning of the 30th October with its centre off Masulipatam at about 150 miles from the coast. The storm moved very slowly in some direction between north and northwest, and on the following morning its position was just off Waltair. It crossed the coast at about midnight of the 31st October passing over Puri. It was accompanied along its path by heavy rain and high winds.

The action taken with regard to Puri, as representing the part of the coast most affected, is shown by the following telegrams:—

30th October 10 25 hrs. Hoist great danger signal number one. Storm at present moving towards coast near Calingapatam but may curve to north Take precautions. (The signal hoisted indicated that a storm of great intensity was threatening the port and would cross the coast to the south of it)

30th October 11 hrs. Storm signal hoisted at Saugor.

31st October 10·5 hrs. Storm now of considerable intensity still about latitude seventeen or eighteen moving very slowly. May cross today between Waltair and Puri. Take every precaution.

1st November 9·50 hrs. Lower storm signal, storm now inland with centre to west of Midnapore. Weather rough head of Bay but will improve quickly.

1st November 10·34 hrs. Storm signal lowered at Saugor.

Considerable damage was caused in Eastern Bengal by high winds and heavy rain. The usefulness of the warnings issued to that part of the coast may be judged from a letter received from the India General Steam Navigation Company, Calcutta, thanking the Department for " the very satisfactory manner in which their representative at Goalundo was kept informed of the track and intensity of the storm."

25. From the above it would appear that the movements of the storms were correctly anticipated and that the warnings were timely and ample.

WARNINGS FOR STORMS IN THE ARABIAN SEA DURING THE YEAR.

26. There were in the Arabian Sea three storms and six periods of disturbed weather not connected with any definite storm ; for all of these warnings were issued.

(1) In October a depression which appeared off Madras on the 21st travelled across the Peninsula out into the Arabian Sea during the 22nd. Its exact course in the Arabian Sea cannot be determined, but the mail steamer which left Aden on the 27th met in Lat. 16 N. Long. 58 E. on the morning of the 30th a strong easterly gale with considerable sea indicating that the depression had increased to a storm and had moved westwards.

On the morning of the 22nd the ports on the west coast of the Peninsula were informed that a depression was crossing the Peninsula and might pass into the Arabian Sea and give rise to squally weather.

The following telegrams were sent to Aden, and similar information was supplied to Indian ports and Colombo :—

23rd October 11·25 hrs. A depression has crossed Peninsula into Arabian Sea near Goa. It is now very shallow but it may intensify and move westward. Hoist cautionary signal.

24th October 11·27 hrs. Disturbance now off Ratnagiri and moving slowly in some northerly direction. Intensity cannot be judged.

25th October 13·0 hrs. At 8 hrs. this morning disturbance a little south of Bombay. Probably has not yet developed into a storm.

26th October 11·48 hrs. No definite indications that storm has yet formed, but area of unsettled conditions appears to be moving towards Kathiawar coast.

27th October 12·0 hrs. Disturbance almost ceased to affect coast stations so that it is either filling up or moving westwards.

28th October 11·37 hrs. No signs of depression in Arabian Sea are visible at coast stations. It has therefore probably filled up but may possibly have moved westwards.

29th October 12·45 hrs. Depression apparently filled up. Lower signal.

(2) Two depressions which passed in quick succession over Ceylon into the south of the Arabian Sea appear to have united into a cyclonic storm on the 20th November, which moved rapidly northwards and struck the coast just north of Bombay at about noon on the 22nd. The storm was very abnormal in the rapidity of its movement and the path it took, and it did considerable damage to Bombay harbour, where five lives were lost and twenty-seven small vessels were wrecked.

The action taken with regard to Bombay as representing the part of the coast most affected is shown by the following warnings :—

17th November 16·5 hrs. Feeble depression passing south Cape Comorin from Bay into Arabian Sea. May give squally weather off Malabar coast.

18th November 11·50 hrs. The depression has now passed into Arabian Sea and probably has its centre near Maldives. Squally weather likely over southeast Arabian Sea.

19th November 11·49 hrs. Another depression has appeared over Ceylon and will probably move westwards. With the one already in the south of the Arabian Sea may cause squally or rough weather there.

20th November 11·55 hrs. Depression from Ceylon now over Laccadives may develope into storm. Probably move northwestwards at first. Hoist cautionary signal.

21st November 11·52 hrs. Storm apparently formed four hundred miles off Konkan coast. Will probably move towards Kathiawar coast. Lower cautionary hoist warning signal.

22nd November 4·15 hrs. Storm centre approximately two hundred miles west of Bombay. Intensity cannot be determined but probably moderate or considerable. Likely cross coast east of Veraval. Hoist danger signal number two.

22nd November 10·50 hrs. Storm centre at eight hours this morning fifty miles northwest of Bombay. Probably cross coast fifty or hundred miles north Bombay about noon. Lower danger signal number two. Hoist danger signal number three.

22nd November 16·48 hrs. Storm centre passed inland but high winds still possible.

22nd November 22·0 hrs. Storm centre now well inland. Lower signal.

(3) A disturbance developed in the vicinity of Ceylon about the middle of December; on the morning of the 18th it was central near and to the west of Colombo, and on the 19th to the west of Malabar. It probably filled up during the next three days while moving westwards. It was presumably a concentrated disturbance and is reported to have done some damage at Colombo.

The following telegrams were sent to the Malabar coast ports :—

18th December 12·17 hrs. Cyclonic storm formed with centre about hundred miles west of Colombo. Probably move west or northwest. Suggest hoist cautionary signal.

19th December 11·50 hrs. Storm slight intensity passed into southeast Arabian Sea yesterday afternoon, now probably near seventy-two degrees east ten north.

20th December 12·0 hrs. Storm probably now centre Arabian Sea where weather is disturbed south of latitude sixteen.

21st December 11·47 hrs. Weather continues disturbed south of latitude eighteen but position and intensity of disturbance uncertain.

22nd December 11·37 hrs. Disturbance either dissipating or moving away to the westwards. Suggest lower signal.

23rd December 11·24 hours. Disturbance disappeared.

27. In the case of the first storm, as usually happens with storms that pass away to the west, the observations at the coast stations gave little or no indications of its movement; but the warnings given for the second and third were satisfactory.

Flood Warnings and Weather forecasts to District, Irrigation Railway and other Officers.

28. This work is carried out chiefly by the Simla Meteorological Office, but partly by that of Calcutta. The arrangements have been made at various times, and differ considerably in character, according to the nature and extent of the flood or weather warnings required by the officers concerned. In some cases these officers require telegrams warning them of advancing storms likely to give heavy rain, or of actual heavy rainfall, likely to give rise to severe floods which might injure railways or canal works; and in others they require warnings or forecasts of the weather for as long a period beforehand as possible, so as to enable them to modify their arrangements for carrying on the works under their charge so far as may be necessitated by sudden or large changes of weather.

The number of district officers and officers in the irrigation, railway and other departments requiring warnings from Simla amounted at the end of the year to 127, an increase of 23 during the year.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Karachi, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

29. The number of warning messages sent from Simla during the year 1912-13 was 1,826, as compared with 1,352 in 1911-12 and 2,649 in 1910-11.

The number of warnings for heavy rainfall sent from Calcutta during the year 1912-13 was 455 as compared with 91 in 1911-12.

30. Instructions were issued by the Government of India in 1898 that every officer to whom storm or flood warnings are issued, should in the month of January of each year or in the case of military expeditions at the close of the campaign, forward to the head of this department a brief return of the warnings received during the past year, and should also report :—

(1) Whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

(2) Whether the warnings were timely and satisfactory in every respect, and, if not, in what points they were defective.

(3) Whether any changes might be made in the system which would make the warnings more useful.

Reports on the ordinary storm and flood warnings for the calendar year 1912 were received from 46 officers. Of these 29 reported that the warnings were timely and satisfactory and were rapidly transmitted by the Telegraph Department; 15 offered no remarks and two reported that they had received no warnings during the year.

A comparison of the reports of floods and of heavy rain with the information supplied to the various officers would appear to show that the system is working satisfactorily, and that most of the warnings issued were timely and of use to the recipients. No suggestions were put forward by the officers concerned for changes or improvements in the flood warning service.

SEASONAL FORECASTS.

31. The forecast for the monsoon period of 1912 dated the 8th June, was sent to Local Governments and Administrations, communicated to the press and printed in the Gazette. A statement of the rainfall of June and July with a forecast for August and September was drawn up on the 8th August 1912 and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was drawn up on the 11th January 1913 and sent to Local Governments and Administrations.

The following are summaries of these two forecasts, and a comparison of them with the actual rainfall :—

Forecast, dated 8th June 1912.	REMARKS.
(*a*) It appears likely that monsoon rainfall, which is already overdue on the Konkan coast, will be materially later than usual in establishing itself over the country.	The monsoon was not established over the greater part of central and northern India until early in July.
(*b*) The rainfall of the first half of the period is likely to be less abundant and less steady than usual, particularly in northwest India.	The rainfall over India of June was in defect by 28 per cent and the deficiency was over 50 per cent in the United Provinces, the Punjab, the North-West Frontier Province, Rajputana, Central India, the Central Provinces and Hyderabad. The unfavourable conditions lasted until July 6th, but after July 11th the monsoon was unusually vigorous until the end of the month with the exception of a few days.
(*c*) There appears to be no reason for anticipating that the total monsoon rainfall of India as a whole will be in large excess or large defect.	The defect was only 1·74 inches, or 5 per cent.
(*d*) An unusual amount of irregularity in the distribution of rainfall appears likely.	The actual rainfall showed a large amount of irregularity in the distribution over the country in the successive months.

Forecast, dated 8th August 1912.	Remarks.
(*a*) The total rainfall of August and September is likely to be in excess.	The rainfall of August was in excess by 0·71″ or 7 per cent, but that of September was in defect by 1·94″ or 28 per cent.
(*b*) The distribution of rain may be expected to favour the northeast of the Peninsula, the central parts of the country and Rajputana at the expense of the tracts lying north of a line through Dacca, Gaya and Lucknow to Mussooree.	During August in the area for which an excess was predicted it occurred in all the divisions except in Central India East, while in the area for which a defect was anticipated it occurred at the majority of the telegraphic stations representing it. In September, however, the forecast did not hold.
(*c*) It appears improbable that there will be any prolonged general breaks.	This was correct for August but not for September.
(*d*) There is no reason for expecting any unfavourable influence of snowfall upon the monsoon in northwest India.	No such influence was shown.

It may be claimed that the June forecast was correct in its main features; but while the forecast for the second-half of the monsoon period was correct for August it failed for September.

32. A forecast of the probable character of the rains during January and February 1913 was prepared on the 3rd January 1913 and issued in the same manner as the forecast of the previous June. On the 25th July 1913 a comparison of the actual precipitation with the above forecast was issued.

The summary of the forecast issued was—

The indications are unusually conflicting, and do not point to a very severe or a very mild winter. It appears, however, that in the rainfall of northwest India, a defect is more likely than an excess.

The season actually was extraordinarily dry in January and the first half of February, during which period practically no rain fell and very little snow. In the latter half of February, however, the rainfall was nearly four times the average, while the snowfall was in very large excess. The total precipitation of the two months was in this way brought very nearly up to the ordinary amount, both in rain and snow.

Thus the season was of very uncertain character and rainfall was on the whole two per cent in defect. The indications given by the forecast, though not very definite, were fairly correct.

Daily telegraphic weather summary.

33. The summary was despatched daily at about noon.

It was exhibited at certain telegraph offices, and sent to 94 officers of Government. The subscribers, for longer or shorter periods, were 10 newspapers and 47 private individuals.

Publications.

34. There were no changes made during the year in the routine publications of the Department, of which a description will be found in the Departmental Administration Reports of 1907-08 and 1910-11.

The following memoirs of the Indian Meteorological Department were published during the year 1912-13:—

(1) "Data of heavy rainfall over short periods in India"; by Gilbert T. Walker, C.S.I., M.A., Sc.D., F.R.S., Director-General of Observatories. (Memoirs of the Indian Meteorological Department, Volume XXI, Part III.)

(2) "The rapid calculation of times of moonrise and moonset"; by J. H. Field, M.A., and S. M. Jacob, I.C.S. (Memoirs of the Indian Meteorological Department, Volume XXI, Part IV.)

(3) "The liability to drought in India as compared with that in other countries"; by Gilbert T. Walker, C.S.I., M.A., Sc.D., F.R.S., Director-General of Observatories. (Memoirs of the Indian Meteorological Department, Volume XXI, Part V.)

SUPPLY OF METEOROLOGICAL INFORMATION.

35. In addition to the meteorological information published by the department special information was supplied to the Meteorological Departments of England, Australia and Egypt, and to the Solar Physics Committee, London.

Climatological information, at times involving special calculation, is also provided for sanitary and other officers of Government, as well as for private firms who are willing to pay the expense necessarily incurred. The extent to which the department is utilised in this manner is increasing steadily.

MISCELLANEOUS.

36. Four hundred and thirty-nine books and pamphlets, either purchased or presented by scientific bodies, were added to the Library during the year. The Library is on the whole in fair order.

Nine libraries, observatories or societies were added during the year to the list of institutions to which the publications of the India Meteorological Department are supplied, and sixteen were removed; the number on the list is now 390.

CHIEF FEATURES OF THE YEAR.

37. The work of the department may be regarded as having two objects, (1) the directly useful, and (2) the scientific, aiming at ascertaining facts which shall be of practical usefulness in the near future. That which comes most completely under the former heading consists chiefly of the collection and distribution of current weather information, the supply of climatological data, the issue of storm and flood warnings and the provision of time signals. The scientific work includes the experimental and theoretical examination of the physical processes which determine the weather.

38. At the beginning of the year under review there was a serious risk that the Simla gazetted staff would be permanently reduced, and that any scientific enquiries with the object of improving our methods would consequently become impossible while the work of the department would be confined to the mere supervision and publication of meteorological measurements. Happily this disaster has been averted, and sanction was given in July 1912 for a new appointment on the Simla staff. At the same time sanction was given for a scheme of enquiry into the meteorology of the upper air, the sum of three lakhs being granted for ten years' work under the charge of Mr. J. H. Field, whose services were to be entirely given to this purpose. Unfortunately Mr. Field's health had given way under the strain caused by the shortness of staff that had prevailed since 1910, and his absence on furlough prevented all work on the scheme except preliminaries in connection with sending up pilot balloons at Simla and Darjiling and preparations for the new observatory at Agra, which will be the headquarters.

The new assistant at Simla whose appointment was sanctioned in 1912 and who was to have come out last October has not yet arrived. While therefore the ordinary routine work has been efficiently carried out, it has been found impossible to prevent a number of special pieces of work from falling seriously into arrears. As an example of these may be taken the fact that readings of our departmental standard barometer at Calcutta are believed to differ from that at Kew by ·011", and an expensive absolute instrument capable of giving the true correction of our standard to a sufficient degree of accuracy came out from Europe some years ago. In spite however of the desirability of establishing a correct basis of comparison for the barometers of India it has not been possible to spare an officer

from Simla for three weeks to go to Calcutta and perform the somewhat difficult operation of filling and erecting it. From the same cause the Simla gazetted staff has been unable to carry out any systematic scientific enquiry.

On the routine side perhaps the most important changes have been in connection with our marine work. The introduction of installations for wireless telegraphy on a number of ships led to a demand for weather information for ships at sea, and an arrangement was accordingly made that a very short statement should be telegraphed daily to the wireless stations on the coast for transmission to any ship that asked for it. A beginning has also been made with the organisation of a system whereby meteorological observations should be made on ships on certain routes and telegraphed to Simla or Calcutta for use in connection with daily weather work and storm warning: it is obvious that information obtained in this way will at times be of the greatest value and the shipping companies have shown every willingness to co-operate.

Concluding Remarks.

39. The Meteorological Department owes a large part of its usefulness to the sympathetic assistance it receives from outside departments. Civil Surgeons and other officers of the Medical Department, as unpaid superintendents of observatories and in other capacities, help in the daily record of meteorological work; the Telegraph and Postal Departments assist in every way in the rapid transmission of meteorological information, at the same time that they allow their employees to act as observers. The Eastern Telegraph Department, by transmitting the daily Aden message free, and the Indo-European Telegraph Company by giving free transit to the daily records of the Persian observatories, place a large volume of most valuable information at the disposal of the Meteorological Department.

Weekly telegrams were received from the 1st May to the 15th October from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams gave valuable information of the weather conditions in the Indian Ocean and the Department is indebted to the officers indicated for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the India Meteorological Department.

The Department is greatly indebted for important information as to meteorological conditions prevailing antecedent to and during the southwest monsoon, to the Director of the Government Observatory, Durban; the Director, Agriculture and Forestry Department, Zomba, British Central Africa; the Meteorologist, Dar-es-Salaam; His Majesty's Commissioner, Entebbe, Uganda; the Director-General, Survey Department, Cairo; the Commonwealth Meteorologist, Melbourne; the Directors of the Observatories at Buenos Ayres and Santiago; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

The central office of the Meteorological Department at Simla was under the charge of Dr. Walker throughout the year under review and the general administration of the Department was in his hands, while the local officers who have helped very materially with the current work of the Department were as follows:—Calcutta, Mr. C. W. Peake and Dr. E. P. Harrison; Madras, Mr. R. Ll. Jones; Bombay, Mr. H. A. Armstrong and Mr. G. W. Talbot; and Allahabad, Dr. E. G. Hill and Mr. A. P. Sircar.

GILBERT T. WALKER,

Director-General of Observatories.

Simla, the 21st August 1913.

177MRGI—290—24-9-13—GCBP Simla

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

REPORT

ON

THE ADMINISTRATION

OF

THE METEOROLOGICAL DEPARTMENT

OF

THE GOVERNMENT OF INDIA

IN

1913-14.

CHANGES IN THE STAFF DURING THE YEAR.

Mr. J. H. Field was on privilege leave from 31st August 1912 to 30th November 1912 combined with furlough from 1st December 1912 to 19th October 1913.

Mr. C. W. B. Normand joined the department as Imperial Meteorologist in Simla in October 1913.

Mr. W. A. Harwood was on privilege leave from 15th January 1913 to 13th April 1913. Mr. Bion acted.

Mr. J. Evershed was deputed to New Zealand from 11th December 1913 to 10th March 1914. He was on privilege leave from 4th August to 3rd November 1913. Dr. Royds acted.

Mr. C. W. Peake was on combined leave from 17th April 1913 to 16th December 1913 which was extended to 1st February 1914. Dr. Harrison acted.

Dr. E. G. Hill was on leave from 29th April 1913 to the end of the year. Dr. A. P. Sircar acted.

Mr. R. Ll. Jones was on furlough from 3rd April 1913 to 30th November 1913. Messrs. Simonson and Littlehailes acted.

Dr. Royds was on privilege leave from 14th to 28th March 1914.

OBSERVATORIES.

2. The observatories maintained by the Government of India are classified as follows :—

First Class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, and wind direction and velocity, in addition to instruments read by eye.

Second Class.—Observatories at which readings are taken daily at 8 hrs., 10 hrs., and 16 hrs.: those at 8 hrs. are (with a few exceptions) transmitted by telegram to one or more of the offices at Simla, Calcutta, Bombay and Madras for inclusion in the India or Provincial Daily Weather Reports.

Third Class.—Observatories—

(a) where readings are taken daily at 8 hrs. only; at those stations where there are telegraph offices the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports;

(b) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determination of monthly and daily means which should be comparable with the means already obtained for second class observatories.

Fourth Class.—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only are recorded.

Fifth Class.—Observatories which telegraph rainfall only.

3. At the end of the year the total number of observatories was 289 of which 50 were non-departmental and 239 were maintained by the Government of India. Of the 239 departmental observatories, 7 were first class, 3 second class, 184 third class, 24 fourth class, and 21 fifth class.

4. The third class observatory at Hambantota under the superintendence of the Director Colombo Observatory started sending daily observations to this department from the 15th August 1913, and a fifth class observatory was opened at Parbhani on 1st May 1913.

As regards departmental observatories, the following were the changes:— a third class observatory was opened at Lyallpur on 18th August 1913; a fifth class observatory was opened at Mussoorie on 26th October 1913; and the observatory at Ootacamund was reduced from second to third class on 17th June 1913.

First Class Observatories.

5. The Directors of the Observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded for the information of Government. It has accordingly been ruled as unnecessary to include information relating to the working of these observatories in this Administration Report.

6. At Alipore (Calcutta), Allahabad and Lahore the following special instruments were in use during the year:—

Alipore.	Allahabad.	Lahore.
Bergholz barograph.	Beckley anemograph.	Draper barograph.
Kew barograph.	Richard barograph.	Richard barograph.
Kew thermograph.	Richard thermograph.	Casella rain-gauge.
Richard thermograph.	Stokes sunshine recorder.	Beckley anemograph.
Beckley anemograph.	Solar radiation thermometers.	Sunshine recorder.
Dines' pressure tube anemometer.	Grass thermometer.	Grass thermometer.
Beckley rain-gauge.	Ground thermometer.	Nephoscope.
Monthly rain-gauge.	Nephoscope.	Ground thermometer.
Hellman Fuess rain-gauge.	Lawrence and Mayo self-recording rain-gauge.	
Milne seismograph.		
Grass thermometer.		
Ground thermometer.		
Nephoscope.		

7. *The Alipore Observatory.*—This observatory is under the charge of the Meteorologist, Calcutta.

The autographic instruments have on the whole worked satisfactorily during the past year.

All instruments issued by the Meteorological Department are tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 768 as compared with 1,207 last year. 66 instruments were condemned as unfit for issue, or were sent to the India Office for repair and 15 instruments were kept in store for future treatment. In addition to the above, 268 instruments were examined and issued to other observatories.

The observatory gives mean Calcutta time to the port and shipping. Three time balls are dropped daily at 1 P M., local mean time throughout the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore Docks.

This work was carried out quite satisfactorily as far as this department is concerned. There were 36 failures as compared with 15, the average number of the past 25 years; but in all cases they were due to defects in the electric or mechanical arrangements outside the observatory, for which this department is not responsible.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraghic defects.
1913-1914	36	36
1912-1913	50	50
1911-1912	21	21
1910-1911	21	20
1909-1910	28	27

8. *The Allahabad Observatory.*—This observatory is under the charge of the Meteorologist, Allahabad.

Beckley anemograph.—This instrument worked somewhat better during the year under review than it did the previous year. There were fourteen breaks which were due principally to the stopping of the clock.

Richard barograph.—This instrument again gave excellent tracings throughout the year: all the charts have been tabulated.

Richard thermograph.—The wet bulb tracings went wrong in Octobor 1912 and its use was discontinued. The dry bulb tracings, with a few exceptions, have been good.

Sunshine recorder.—This gave good results with a break.

Nephoscope.—Regular observations were made with the Duboscq instrument.

Readings of all the eye instruments were taken every two hours from 8 hours to 18 hours. The earth thermometer on the surface was read at 14 hours. In addition to the ordinary observations, special observations of cloud for use at the Aerological Observatory at Agra have been taken since 1st March 1914.

9. *The Lahore Observatory.*—Eye observations of the ordinary Meteorological instruments were taken seven times daily at this observatory as in past years at 6, 8, 10, 14, 16, 18 and 22 hrs. Ground surface temperature was recorded four times daily at 6, 10, 16, and 22 hrs.

CHARACTER OF THE WORK OF OBSERVATION AT SECOND AND THIRD CLASS OBSERVATORIES.

10. The general character of the work of the observatories, as judged by the number of mistakes made by observers was satisfactory.

The number of stations of great reliability, in which either no mistake or only one mistake has been detected in the data for the Indian Daily Weather Report, was 39 as against 45 in 1912-13; while, the number of stations at which more than 50 mistakes were made was 11 as against 18 last year.

These results are of interest in connection with the fact that on the 1st January 1914 was intruduced the new code for telegraphing observations in figures instead of in words; the change effects a saving of time both in preparing and decoding the messages.

The usual list showing the number of mistakes in observation and in the preparation of telegrams for all the observatories which send weather telegrams to the Simla office was prepared and circulated to the observatories on the 27th August 1914.

Inspection of Observatories.

11. The number of visits paid to observatories during the year under review was 69 as compared with 56 in the previous year and an average of 60 during the past 10 years.

The Director-General inspected the observatories at Calcutta, Bombay, Alibag, Madras, Kodaikanal, Lahore, Bikaner and Karachi; Mr. Hem Raj inspected 26; Mr. Gaetane 20; Mr. Subrahmanyam 9; Mr. V. Daraiswamy Iyer 1; the Chief Observer, Allahabad 1; Mr. Mukerjhi 1; Mr. Biswas 2; and Mr. Ahmed-Ullah 1.

Of the 63 second or third class observatories that were visited 34 were reported as good, 23 as tolerable and 6 as bad.

Condition.	Second or third class observatories inspected in					
	1913-14.	1912-13.	1911-12.	1910-11.	1909-10.	1908-09.
Good or satisfactory	34	31	20	23	25	40
Tolerable	23	17	16	31	11	20
Bad	6	3	1	3	4	2
Total ...	63	51	37	57	40	62

In estimating the general character of the observatories from the above table it must be remembered that it is, as a rule, on account of something unsatisfactory that a visit of inpection is made. The general level of the stations is thus decidedly better than might otherwise appear. The most frequent cause of bad work is the changing of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments.

Special Observations.

12. Observations other than those recorded by local observers at regular intervals are made as follows:—

(*a*) In accordance with orders issued from the Simla or Calcutta office, when weather is disturbed and storm warnings may have to be issued: such observations are sent by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Re. 1 for each set of special observations sent under instructions from either Simla or Calcutta. The number of telegrams of the latter class forwarded during the year under review was 529, as compared with 607 despatched the previous year.

(*b*) Certain observers, when they consider that conditions at sea are sufficiently threatening, send of their own initiative to Simla or Calcutta a telegram containing special observations. Seven such telegrams were received.

(*c*) In connection with flood warning a number of observers have been instructed to send telegrams announcing the occurrence of heavy rainfall to Government officers and railway engineers who desire early information. The number of telegrams so sent was 126 as compared with 159 last year.

(*d*) Observers are instructed to send detailed information of earthquakes to the Simla Meteorological office and to the Director, Geological Survey, Calcutta: for this work they are paid awards from this department. Of such reports 79 were received during the year.

Observations with special Meteorological Instruments.

13. The following special observations were carried out during the past year at certain selected stations:—

1st—Wind observations recorded by Beckley anemographs at 11 stations, and by Dines' pressure tube anemometers at 4 stations.

2nd—Solar and terrestrial radiation observations at 3 and 10 stations, respectively.

3rd—Underground temperature observations at 3 stations.

4th—Sunshine observations at 7 stations.

5th—Barometric observations recorded by self-registering instruments, chiefly Richard barographs, at 18 stations.

6th—Temperature observations recorded by self-registering instruments, chiefly Richard thermographs, at 11 stations.

Observations of solar energy in absolute units.

14. Observations were continued at Simla throughout the year, when weather conditions allowed, by means of Angstrom's electric pyrheliometer.

Observations in the upper air.

15. Delay in the building work of the observatory at Agra necessitated the employment of such temporary quarters there as could be obtained, and shortly after the return of Mr. Field from leave in October work with pilot balloons was started in Agra. At Simla balloons were sent up almost daily throughout the year and at Darjiling similar work was done during the period preceding the monsoon of 1913. The more serious parts of the intended work at Agra and elsewhere cannot be begun until some months after the completion of the observatory buildings. Reductions of past observations progressed far towards completion during the year, and the analysis by Mr. Harwood of anemograph records at six stations in India was completed for publication in the departmental memoirs.

Researches by the Simla Staff.

16. It was not found possible to carry out any continuous experimental investigations at Simla, but a special grant for a computing staff enabled progress to be made with work of a statistical character. The tabulation of the past rainfall of India which had suffered in accuracy from frequent changes in the past normals was carried out afresh on a uniform system. An examination was made of the extent to which a forecast of the monsoon rainfall could be derived from the temperature of India, from the pressure of India in the previous year and from the quantity of ice off Cape Horn; and some advance was made in the problem of forecasting the local distribution of monsoon rainfall. A substantial contribution towards our knowledge of Indian daily weather also was made in the compilation of 125 charts illustrating important types of weather for future reference and study.

Seismograph Observations.

17. Seismological observations were recorded by two Omori-Ewing seismographs at Simla and one at Bombay; by Milne seismographs at Alipore (Calcutta), Kodaikanal and

Colaba (Bombay); and by means of other self-registering instruments at the last named station. All the instruments worked satisfactorily throughout the year, and copies of the records of the Milne's seismographs were transmitted to the Seismological Committee of the British Association.

Marine Meteorology.

18. No change was made during the year under review in the method of collecting marine information.

At Calcutta and Bombay a clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard, for the purpose of applying the necessary corrections to the readings in the logs; and, after the barometer comparisons have been made a statement of the error of the ship's barometer is given to the captain, in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port, but it is ample for the purposes of the department.

The data thus obtained are utilised in the preparation of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department, and in drawing up an account of the storms of the year for publication in the Annual Summary.

The arrangements made with the London Meteorological Office, the Royal Alfred Observatory at Mauritius, and the Deutsche Seewarte, Hamburg, for collecting marine data from the whole of the Indian Ocean, have been continued and the thanks of this department are again due to these three offices for thus supplying a large amount of useful data.

Observations recorded during the year at the entrance of the River Hughli were supplied to the Meteorological Department by the light-vessels "Comet" and "Luna."

Snowfall Registration in the Mountain Districts to the North and West of India.

19. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete, and the thanks of the department are again due to the various officers who have collected and forwarded it. Additions to the information received have been obtained by continuing the series of large-scale photographs of the snows, as seen from Simla, which was started in 1905.

Rainfall Registration.

20. The registration of rainfall in India has invariably been carried out by the provincial authorities. In 1889 a uniform system was introduced by the Government of India, and the Director-General of Observatories was made consulting officer in connection with this work. His advice is sought regarding the starting of new raingauge stations, and he receives annual reports from the local officers responsible for the registration of rainfall upon the efficiency of the work. A general account of the system, which came into operation in the year 1891-92, will be found on pages 5-8 of the Administration Report of the year 1889-90, and on pages 6 and 7 of the Administration Report for the year 1890-91.

The following is a statement of the number of rain-gauge stations from which data were being received for publication in the Rainfall Data of India at the end of the year under review :—

Province or Division.	Number of rain gauges supplying returns for publication on 31st March 1914.	Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1914.
Burma	200	Baluchistan	94
Assam	125	Rajputana	185
Bengal	225	Bombay and Sind	289
Bihar and Orissa	281	Central India	117
United Provinces	277	Central Provinces	174
Punjab	188	Hyderabad	22
Kashmir	37	Mysore	77
North-West Frontier Province ...	33	Madras (including Pudukkottai, Coorg, Travancore and Cochin).	502

The following paragraphs give a b ief summary of the reports of the officers in charge of rainfall registration for the year 1913-14 :—

Assam.—The total number of rainf ll stations was 125 against 124 in the preceding year. The number of gauges inspected was 91 or an increase of 29 over the previous year. In Cachar and Nowgong more than half the raingauges remained without inspection. Inspections of 38 raingauges were made more than once.

Baluchistan.—There were at the close of the year 95 raingauges : of these 45 were maintained by the railway department at railway stations, while 42 (excluding those attached to departmental observatories) were under the civil and irrigation departments. Seventeen rainfall stations were inspected, and the results were, on the whole, satisfactory.

Bihar and Orissa.—The total number of rain-registering stations during the year was 282 (including 22 stations situated in the Feudatory States and Tributary Mahals) against 258 last year. 150 stations were inspected and 111 inspection cards were received against only 34 cards received last year. The raingauges were mostly in good condition and registration work was generally done satisfactorily in most of the districts.

Bengal.—The number of rainfall stations remained the same as last year, 225. Of these, only 48 were inspected, while last year 60 were inspected, and the year before 108. There is need to impress upon rainfall registration officers the necessity for more regular and systematic inspection in future.

Bombay and Sind.—There were 276 raingauges (excluding those in Native States) of which 213 were inspected during the year under review against 209 inspected last year—101 were inspected more than once and the total number of inspections amounted to 355 against 299 in the preceding year. Sufficient attention was not paid to the work in three districts of the Deccan, two each in the Karnatak and Gujarat and one each in Konkan and Sind, and the attention of the Collectors concerned is being invited to the matter. As regards Native States, 38 gauges only (out of 61) were inspected against 41 last year and 44 the year before. Seven raingauges were inspected more than once against four last year.

Burma.—As reported last year there are 200 rain-recording stations of which 19 are meteorological observatories and 26 in charge of the Public Works Department. 156 raingauges were inspected, or 2 in excess of last year. Of these, 106 were found in good, and 50 in a fair, condition.

Central Provinces.—The number of raingauges maintained during the year was 112 against 111 in the previous year. The number of inspections of which reports were received was 121 against 133 in the preceding year. The results during the year were on the whole satisfactory.

Hyderabad.—Information not yet received.

Kashmir.—There are 36 rain-recording stations in the state of which 8 are meteorological observatories and the remainder are in charge of the Revenue Department. The number of inspections of raingauges of which reports were received was 5 only against 10 inspected last year. The local authorities are being addressed by the local Government in the matter.

Madras.—There were 475 rain-recording stations at the close of the official year of which 391 were in the Madras Presidency. The number of stations inspected was 377 as against 380 inspected the previous year.

Mysore.—At the close of the calendar year 1913 there were 223 rain-recording stations as against 220 in the previous year. Out of these 193 or 87 per cent were inspected as compared with a percentage of 85 last year.

North-West Frontier Province.—The report on rainfall registration contained in the current administration report of the North-West Frontier Province refers to the year 1912-13 and states that the raingauges and rainfall registers were maintained in good condition. A new raingauge was established at the Tarnab Agricultural Farm.

Punjab.—The total number of raingauges in the Punjab during the calendar year 1913 was 222 or 13 more than last year. Of these, 152 were in charge of district officers and 70 under canal officers. There were 51 inspections against 47 last year. The raingauges under both district and canal officers are reported to be in good order and the records well kept up.

United Provinces.—There were 287 rain-reporting stations in these Provinces including the meteorological observatories. Out of the 273 stations under the supervision of district and canal officers, 160, *i.e.*, 58 per cent, were inspected during the year.

Summary.—In the Central Provinces, Madras, Mysore, Bombay and Burma, over 75 per cent of the rainfall stations were inspected ; in the United Provinces, Assam, and Bihar over 50 per cent ; Bengal 21 per cent ; Punjab 23 per cent ; Baluchistan 18 per cent ; and Kashmir 14 per cent.

THE SYSTEM FOR STORM WARNING.

21. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed from the Simla Office by the Director-General of Observatories, and from the Calcutta Office by the Meteorologist, Calcutta.

The following ports are warned from Simla for storms in the Arabian Sea :—

Aden, Karachi, Cutch Mandvi, Jamnagar, Dwarka, Porbandar, Veraval, Jafarabad, Bhavnagar, Daman, Bombay, Alibagh, Murud Janjira, Harnai, Ratnagiri, Malvan, Vengurla, Nova Goa, Marmagao, Karwar, Kumta, Honavar, Mangalore, Tellicherry, Calicut, Cochin, Alleppy and Colombo.

The Meteorologist, Calcutta, warns the following ports for storms in the Bay of Bengal :—

Colombo, Tuticorin, Pamban, Negapatam, Cuddalore, Madras, Masulipatam, Cocanada, Vizagapatam, Calingapatam, Gopalpur, Puri, Hukitala (False Point), Chandbali, Palasore, Saugor Island, Diamond Harbour, Mud Point Budge Budge, Calcutta, Morelganj, Barisal Goalundo, Narayanganj, Noakhali, Chittagong, Cox's Bazar, Akyab, Kyaukpyu, Diamond Island, Bassein, Rangoon, Moulmein, Tavoy, Mergui, Table Island and Port Blair.

22. In addition to special messages sent during stormy weather the Meteorologist, Calcutta, provides shipping during a large part of the year with daily information regarding the weather over the Bay. This information is made available at the following places by means of daily weather telegrams to an officer at the Port or by the hoisting of flag signals :—

Negapatam, Porto Novo, Cuddalore, Madras, Cocanada, Vizagapatam, Calingapatam, Gopalpur, Saugor Island, Chittagong, Akyab, Elephant Point, Rangoon, Moulmein, Kalagauk and Sabang.

23. In accordance with resolutions passed at the International Radio-Telegraph Conference held in London in June and July 1912, the Indian radio-telegraph coast stations are now supplied with telegrams containing meteorological information with regard to the Arabian Sea and the Bay of Bengal for transmission to ships which ask for them. These messages are sent to the radio stations at Bombay, Karachi, Calcutta, Sandheads, Diamond Island, Table Island and Victoria Point.

Arrangements were also made for the receipt by wireless telegraphy of meteorological observations from ships at sea, and the system was introduced during the year. It has worked satisfactorily.

WARNINGS FOR STORMS IN THE BAY OF BENGAL.

24. During the year warnings were issued for nineteen disturbances. Only two of these however developed into storms of any severity and only three were of sufficient importance for a statement to be given here of their course and of the action taken :—

(1) A depression formed on the 22nd July to the east of the Sandheads. It intensified considerably on the 22nd but remained stationary, and on the morning of the 23rd it had developed into a storm of considerable severity with an inner area in which a strong gale was blowing. The centre crossed the coast somewhat east of Saugor Island on the evening of the 24th moving in a west-northwesterly direction.

The Bay ports that were likely to be affected by the disturbance or from which ships might run into it were informed daily from the 22nd. At Saugor Island, Calcutta and the other ports on the Hugli the daily flags had shown on the 22nd that weather was unsettled ; warning signal No. 7, indicating that a cyclonic storm of small extent and intensity would probably move northwards between Saugor Island and Chittagong, was ordered to be hoisted at about 10-30 hours on the morning of the 23rd, and orders were sent at 12-30 next day for replacing it by danger signal No. 9, indicating the approach towards Saugor roads of a cyclonic storm of small extent. This signal was lowered at about 8 hours on the morning of the 25th.

(2) A depression was shown on the morning of the 28th July on the Chittagong coast. It intensified rapidly during the next 24 hours and on the evening of the 29th became a storm of unusual severity with winds of hurricane violence

and tremendous seas. It moved in a westnorthwesterly direction and crossed the coast between Saugor Island and Calcutta on the night of the 30th.

The warnings issued were similar to those used for the preceding storm. Warning signal No. 7 was ordered to be hoisted at about 5 hours on the morning of the 30th at Saugor Island, Calcutta and the other ports on the Hugli, and was ordered to be replaced by danger signal No. 9 about 5 hours later. Orders for lowering the signal were sent at about 8 hours on the morning of the 31st.

(3) A depression appeared to be forming in the Bay off the north Madras coast on the 10th October. It developed into a storm of moderate intensity and moved slowly in northnorthwesterly direction, its centre being roughly 120 miles east of Calingapatam on the morning of the 13th. It crossed the coast between Puri and Gopalpur the same evening.

The action taken with regard to Puri and Gopalpur, as representing the part of the coast most affected, is shown by the following telegrams: —

PURI.

10th October 11·40 hrs. Depression formed 200 or 300 miles southeast of Calingapatam. May move northwest or north.

11th October 10·58 hrs. Hoist warning signal. Depression still about 250 miles southeast of Calingapatam is developing into storm. (The signal hoisted indicated that a storm had formed which would probably advance to that part of the coast on which the port was situated but was still at a considerable distance from it).

12th October 11·48 hrs. Small storm at 8 hrs. about Lat. 17-30, Long. 86-30 moving north.

October 13th 11·32 hrs. Lower warning signal and hoist danger signal No. 2. Storm at 8 A.M. was about 170 miles east of Calingpatam moving north or northnortheast. (The danger signal hoisted indicated that a storm probably of slight to moderate intensity was affecting the port and that its centre would probably cross the coast considerably to the north of the port).

14th October 11·22 hrs. Storm curved to west and crossed coast between Puri and Gopalpur last night.

GOPALPUR.

For this port the action taken was identical except that from the message of the 13th, the words 'Lower warning signal and hoist danger signal No. 2' were omitted.

The present signals of the Hugli ports are not very well adapted for a storm of unusual violence during the rains; and hence the warnings of (1) and (2) underrated the severity of the storms. In the case of (2) it is possible that orders for hoisting the storm signal should have been issued at 10-30 on the 29th.

The warnings for the storm (3) were somewhat affected by the incorrect impression formed as to the position of the storm on the morning of the 13th which led to the view that the storm was travelling north or northnortheast. The signals hoisted at Puri were timely and correct except that they indicated that the storm would cross to the north instead of the south. At Gopalpur, since this port was not regarded as seriously threatened on the 13th, the danger signal was not hoisted: but probably the precautions taken in such cases on the warning and the danger signal are largely identical.

WARNINGS FOR STORMS IN THE ARABIAN SEA DURING THE YEAR.

25 There were 14 periods of disturbed weather in the Arabian Sea for which warnings were issued but none of these disturbances except one developed into a storm. The one exception was of a very unusual kind as it was a winter depression which passed eastwards along the Mekran coast in the month of February, and gave strong winds and rough seas to the west of Karachi. Warnings were issued on the 13th February to all ports on the west coast as far

south as Bombay, and danger signals were hoisted at Karachi and the Kathiawar ports. The storm was shortlived and had passed inland by the morning of the 14th. The following telegrams were sent to Karachi :—

13th February 11-57 hrs. There is a deep disturbance near Pasni travelling eastwards ; weather should be watched. Hoist danger signal number three. (The signal hoisted indicated that a storm of slight or moderate intensity was affecting the port and that it would probably cross the coast over or near to the port).

14th February, 11·30 hrs. Disturbance passed inland. Lower signal.

The unusual character of the disturbance is shown by the fact that this is the only instance on record of a danger signal being hoisted at any of the Arabian Sea ports during the winter.

26. There were thus four serious disturbances in the year, and warnings for all were issued either by Simla or Calcutta ; further the information given was fairly correct and timely.

Flood Warnings and Weather Forecasts to District, Irrigation, Railway and other Officers.

27. This work is carried out chiefly by the Simla Meteorological Office, but partly by that of Calcutta. The arrangements have been made at various times, and differ considerably in character, according to the nature and extent of the flood or weather warnings required by the officers concerned. In most cases these officers require telegrams warning them of advancing storms likely to give heavy rain, or of actual heavy rainfall, likely to give rise to severe floods which might injure railways or canal works ; and in others they require warnings or forecasts of the weather for as long a period beforehand as possible, so as to enable them to modify their arrangements for carrying on the works under their charge so far as may be necessitated by sudden or large changes of weather.

The number of district officer and officers in the irrigation, railway and other departments requiring warnings from Simla amounted at the end of the year to 132 an increase of 5 during the year.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Karachi, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

28. The number of warning messages sent from Simla during the year 1913-14 was 1,840, as compared with 1,826 in 1912-13 and 1,352 in 1911-12.

The number of warnings for heavy rainfall sent from Calcutta during the year 1913-14 was 447 as compared with 455 in 1912-13.

29. Instructions were issued by the Government of India in 1898 that every officer to whom storm or flood warnings are issued, should in the month of January of each year or, in the case of military expeditions, at the close of the campaign, forward to the head of this department a brief return of the warnings received during the past year, and should also report :—

(1) Whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

(2) Whether the warnings were timely and satisfatory in every respect, and, if not, in what points they were defective.

(3) Whether any changes might be made in the system which would make the warnings more useful.

Reports on the ordinary storm and flood warnings for the calendar year 1913 were received from 47 officers. Of these 26 reported that the warnings were timely and satisfactory and were rapidly transmitted by the Telegraph Department ; 19 offered no remarks, one reported that he had received no warnings during the year, and one complained that he had not been adequately warned of the October storm that struck the coast near Gopalpur.

A comparison of the reports of floods and of heavy rain with information supplied to the various officers would appear to show that the system is working satisfactorily, and that most of the warnings issued were timely and of use to the recipients. No suggestions were put forward by the officers concerned for changes or improvements in the flood warning service.

Seasonal Forecasts.

30. The forecast for the monsoon period of 1913 dated the 8th June, was sent to local Governments and Administrations, communicated to the press and printed in the Gazette. A statement of the rainfall of June and July with a forecast for August and September was drawn up on the 9th August 1913 and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was dawn up on the 29th December 1913, and sent to Local Governments and Administrations.

The following are summaries of these two forecasts, and a comparisonof them with the actual rainfall :—

Forecast, dated 8th June 1913.	Remarks.
(*a*) The indications are not sufficiently decided to justifiy a forecast that the total monsoon rainfall of India will be in excess or defect. All that can be inferred is that a large excess or large defect is unlikely.	The total monsoon rainfall was in defect only by 1·88 inches, or 5 per cent.
(*b*) There is no ground for anticipating that accumulations of snowfall will exert a prejudicial influence on rainfall in northwest India.	There was no excess of snow and no prejudicial influence. Rainfall in the Punjab Southwest and the North-West Frontier Province was in excess.

Forecast, dated 9th August 1913.	Remarks.
(*a*) The total rainfall of August and September will probably be normal or in slight defect.	The total rainfall was in defect by 3·34 inches or 20 per cent.
(*b*) In northwest India the monsoon is not likely to be affected prejudicially by snowfall.	There was no excess of snowfall and no prejudicial influence. The deficiency of rain in northwest India was due to the early withdrawal of the monsoon.

Taking first the anticipations regarding the total amount of rainfall, the June forecast that it would not be very abnormal was correct: the existing drought in parts of central and north India is due mainly to irregular distribution of the rainfall and its concentration in the earlier part of the season. The August forecast that the rainfall of the latter half of the period would be normal or in slight defect was too optimistic: the actual defect was large. It may be pointed out, however, that the pressure as derived from the cable from Mauritius was incorrect, being too low by ·025" for May and ·03" for July; so that instead of being favourable in both months, as stated in the forecasts, pressure there was in reality unfavourable. But for this a somewhat less hopeful view of the

season's prospects would have been taken. Both forecasts were correct in anticipating no prejudicial influence of snowfall in northwest India.

31. A forecast of the probable character of the rains during January and February 1914 was prepared on the 22nd December 1913 and issued in the same manner as the forecast of the previous June. On the 11th June 1914 a comparison of the actual precipitation with the above forecast was issued.

The summary of the forecast issued was :—

It is probable that the rainfall of northern India will be in excess, though not to a large extent: and that the snowfall in the neighbouring hills will be approximately normal.

Actually both rainfall and snowfall were in defect in January in northern India taken as a whole; but they were in excess in February, especially as regards snowfall. Thus the rainfall of the two months was on the whole approximately normal and the snowfall in slight or moderate excess. The anticipations for rain were somewhat too sanguine and those for snow not quite sanguine enough.

DAILY TELEGRAPHIC WEATHER SUMMARY.

32. The summary was despatched daily at about noon.

It was exhibited at certain telegraph offices, and sent to 97 officers of Government. The subscribers, for longer or shorter periods, were 10 newspapers and 51 private individuals.

PUBLICATIONS.

33. There were no changes made during the year in the routine publications of the Department, of which a description will be found in the Departmental Administration Reports of 1907-08 and 1910-11.

The following memoirs of the Indian Meteorological Department were published during the year 1913-14:—

"Potential Gradient at Simla, India"; by G. C. Simpson, D.Sc., (Memoirs of the Indian Meteorological Department, Volume XXI, Part VI).

"The cold weather storms of Northern India," Part I by Gilbert T. Walker, C.S.I., M A., Sc. D., F.R.S., Director-General of Observatories; Part II by Rai Bahadur Hem Raj, Imperial Meteorologist. (Memoirs of the Indian Meteorological Department, Volume XXI, Part VII).

"Monthly and annual rainfall normals", by Gilbert T. Walker, C.S.I., M.A., Sc D., F.R.S, Director-General of Observatories. (Memoirs of the Indian Meteorological Department, Volume XXII, Part I).

"Monthly and annual normals of number of rainy days", by Gilbert T. Walker, C.S.I., M A., Sc. D., F.R.S., Director-General of Observatories. (Memoirs of the Indian Meteorological Department, Volume XXII, Part II).

SUPPLY OF METEOROLOGICAL INFORMATION.

34. In addition to the meteorological information published by the department special information was supplied to the Meteorological Departments of England, Australia and Egypt, and to the Solar Physics Committee, London.

Climatological information, at times involving special calculation, is also provided for sanitary and other officers of Government, as well as for private firms who are willing to pay the expense necessarily incurred. The extent to which the department is utilised in this manner is increasing steadily, as will be seen from the chart appended.

MISCELLANEOUS.

35. Eight hundred and seventy-seven books and pamphlets, either purchased or presented by scientific bodies, were added to the Library during the year. The Library is on the whole in fair order.

Nineteen libraries, observatories or societies were added during the year to the list of institutions to which the publications of the India Meteorological

Department are supplied, and sixtyseven were removed; the number on the list is now 342.

CHIEF FEATURES OF THE YEAR.

36. The work of the department may be regarded as having two objects, (1) the directly useful, and (2) the scientific, aiming at ascertaining facts which shall be of practical usefulness in the near future. That which comes most completely under the former heading consists chiefly of the collection and distribution of current weather information, the supply of climatological data, the issue of storm and flood warnings and the provision of time signals. The scientific work includes the experimental and theoretical examination of the physical processes which determine the weather.

Among the projects of the year that may exercise an important influence on the directly useful work of the department is that submitted to Government for reorganising the system of storm warning in the Bay of Bengal and Arabian Sea, and for distributing information to ports and shipping with regard to daily weather. The proposals were drawn up after informal consultations with representatives of commercial and shipping interests and have been circulated to local Governments so that the views may be ascertained of those chiefly affected. Experiments also have been made as to the distance at which day-signals of various shapes and sizes can be distinguished.

During the year progress has been made with the scheme for securing weather observations from ships by wireless telegraphy; a suitable code has been drawn up, tried by a certain number of ships, and printed; and it is clear that at times the information afforded will have great value. It is unfortunate from this standpoint that a large number of the regular tracks of steamships are so close to the land that their observations add little to what is given by our shore stations.

A visit of Dr. Walker to Colombo has resulted in closer co-operation between the meteorological work of India and Ceylon; a daily telegram to Simla and Calcutta has been arranged from Hambantota which will be of great service when warning for storms that form to the southeast of Ceylon.

In order to improve the daily weather forecasts and the system of warning for heavy rain that depends on them, a special grant of money was devoted to the formation of a collection of charts of representative 'types' of Indian weather under the direction of Rai Bahadur Hem Raj. The value of such a collection both for immediate application and for scientific research is obvious.

In 1904, when the normals of rainfall, temperature, etc., were last published, they were based on data up to 1899; and another revision has of late become desirable. This has been effected, and while the normals of rainfall as far as 1910 have been published those of temperature, humidity, cloud and pressure are now in the press.

Sanction was given in 1912 for the appointment at Simla of a new gazetted assistant, in order that scientific researches and consequent improvement in our methods should not become impossible; and three lakhs were given for a scheme of enquiry into the conditions of the upper air to be carried out in ten years by Mr. J. H. Field, whose services were to be entirely given for the purpose. The new assistant Mr. C. W. B. Normand arrived in October and Mr. Field whose health had broken down was able to return to duty in October last. Unhappily the observatory that was being erected for him at Agra was not completed during the year under review and he, with Mr. Harwood his assistant, were forced to occupy temporary quarters; it was not possible to fit up a temporary workshop and laboratory for the few months involved, and their activity was largely confined to work with pilot balloons at Agra and Simla, together with the discussion of data previously accumulated.

Such advances as have been made hitherto in monsoon forecasting have dealt more with the rainfall of India as a whole than with its geographical distribution. Indications regarding the latter had been looked for by Sir John Eliot

in the pressure distribution of India in May, but all methods based on this had failed. When therefore a small computing staff became available a thorough examination of the conditions by strict statistical methods was undertaken. It transpired that the pressure distribution of May had no appreciable influence on the distribution of the succeeding rainfall, but that some of the extra-Indian conditions were of considerable importance: this line of enquiry has shown that the rainfall of certain districts, such as Malabar and Lower Burma, is largely independent of that of the rest of India, and promises to lead to useful results.

Concluding Remarks.

37. The Meteorological Department owes a large part of its usefulness to the sympathetic assistance it receives from outside departments. Civil Surgeons and other officers of the Medical Department, as unpaid superintendents of observatories and in other capacities, help in the daily record of meteorological work; the Telegraph and Postal Departments assist in every way in the rapid transmission of meteorological information, at the same time that they allow their employees to act as observers. The Eastern Telegraph Department, by transmitting the daily Aden message free, and the Indo-Europen Telegraph Company by giving free transit to the daily records of the Persian observatories, place a large volume of most valuable information at the disposal of the Meteorological Department.

Weekly telegrams were received from the 1st May to the 15th October from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams gave valuable information of the weather conditions in the Indian Ocean and the Department is indebted to the officers indicated for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the Indian Meteorological Department.

The Department is greatly indebted for important information as to meteorological conditions prevailing antecedent to and during the southwest monsoon, to the Director of the Government Observatory, Durban; the Director, Agriculture and Forestry Department, Zomba, British Central Africa; the Meteorologist, Dar-es-Salaam; His Majesty's Commissioner, Entebbe, Uganda; the Director, Physical Services, Survey Department, Cairo; the Commonwealth Meteorologist, Melbourne; the Directors of the Observatories at Buenos Ayres and Santiago; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

The central office of the Meteorological Department at Simla was under the charge of Dr. Walker throughout the year under review and the general administration of the Department was in his hands, while the local officers who have helped very materially with the current work of the Department were as follows:—Calcutta, Mr. C. W. Peake and Dr. E. P. Harrison; Madras, Mr. R. LL. Jones, Mr. A. Littlehailes and Mr. J L. Simonson; Bombay, Mr. G. W. Talbot; and Allahabad, Dr. E. G. Hill and Mr. A. P. Sircar.

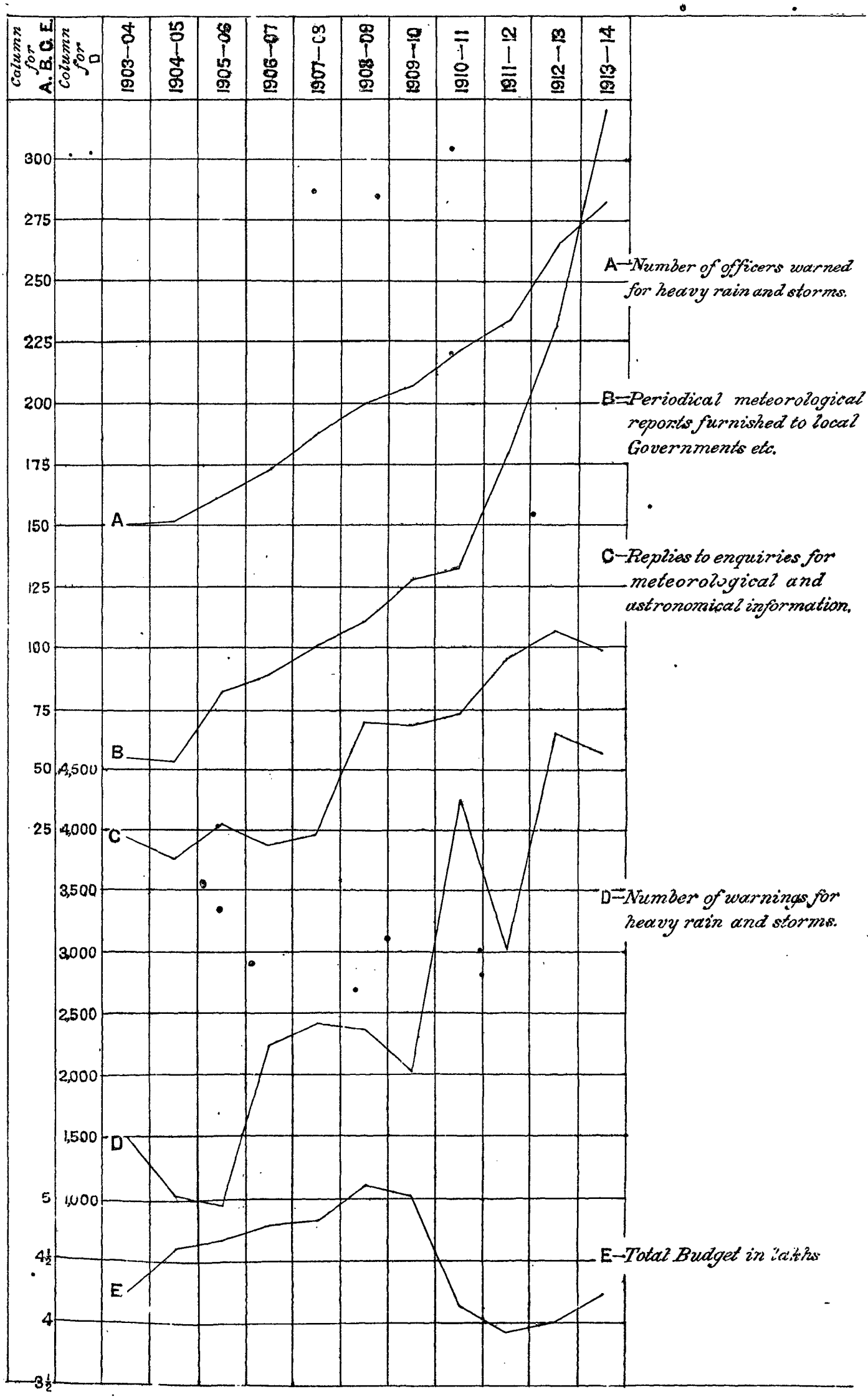
GILBERT T. WALKER,

Director-General of Observatories.

Simla, the 15th September 1914.

198MR GI—290—1-10-14—GCBP Simla

DIAGRAM SHOWING GROWTH IN DEPARTMENTAL ACTIVITY AND CHANGES IN TOTAL COST



LIBRARY
OF THE
BOMBAY
BRANCH
OF THE
ROYAL
ASIATIC SOCIETY

BY

REPORT ON THE ADMINISTRATION OF THE METEOROLOGICAL DEPARTMENT OF THE GOVERNMENT OF INDIA IN 1914-15.

Changes in the Staff during the year.

Dr. Gilbert T. Walker proceeded on eight months' combined leave on 18th March 1915 and Dr. G. C. Simpson was appointed to officiate for him.

Dr. G. C. Simpson was on combined leave from 20th July to 21st October 1914. Mr. Bion acted.

Mr. J. H. Field was on privilege leave from 25th September to 24th October 1914. Mr. W. A. Harwood acted.

Mr. W. A. Harwood was on privilege leave from 16th March to 2nd May 1915.

Rai Bahadur Hem Raj was on privilege leave from 19th June to 18th July 1914. Mr. Bion acted.

Mr. C. W. Peake was on deputation at Simla from 1st July to 30th October 1914 to make a systematic study of storm warning methods. Dr. Harrison acted as Meteorologist, Calcutta.

Dr. T. Royds was on privilege leave from 29th November 1914 to 28th February 1915 combined with Special leave from 1st March to 29th May 1915. Mr. S. Sitaram Aiyar acted.

Dr. N. A. F. Moos was on privilege leave from 31st January to 30th April 1915. Mr. Mukandrai Virshunker Unaker acted.

Mr. G. W. Talbot proceeded on one year's combined leave from 7th November 1914. Mr. W. P. Henderson acted up to 30th April 1915.

Observatories.

2. The observatories maintained by the Government of India are classified as follows :—

First Class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, and wind direction and velocity, in addition to instruments read by eye.

Second Class.—Observatories at which readings are taken daily at 8 hrs., 10 hrs., and 16 hrs.: those at 8 hrs. are (with a few exceptions) transmitted by telegram to one or more of the offices at Simla, Calcutta, Bombay and Madras for inclusion in the India or Provincial Daily Weather Reports.

Third Class.—Observatories—

(*a*) where readings are taken daily at 8 hrs. only; at those stations where there are telegraph offices the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports;

(*b*) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determination of monthly and daily means which should be comparable with the means already obtained for second class observatories.

Fourth Class.—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only are recorded.

Fifth Class.—Observatories which telegraph rainfall only.

3. At the end of the year the total number of observatories was 279 of which 42 were non-departmental and 237 were maintained by the Government of India. Of the 237 departmental observatories, 6 were first class, 3 second class, 184 third class, 22 fourth class, and 22 fifth class.

1DGofO

4. The changes in the observatories during the year were the following:—the first class observatory at Allahabad was reduced to third class on the 9th September 1914; and the fourth class observatory at Srimangal was raised to third class on 20th May 1914. A third class observatory was opened at Hissar on 22nd May 1914, and a fifth class observatory was opened at Harnai on 24th April 1914. The third class observatories at Sirsa, Diego Garcia, and Bahrien were closed on 28th May 1914, 17th July 1914 and 1st January 1915 respectively. The fourth class observatories at Ahwaz, Koweit, Maidan Minaftun, Kermanshah, and Muhammerah were closed on 1st April 1915.

First Class Observatories.

5. The Directors of the Observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded for the information of Government. It has accordingly been ruled as unnecessary to include information relating to the working of these observatories in this Administration Report.

6. At Alipore (Calcutta), Allahabad and Lahore the following special instruments were in use during the year:—

Alipore.	Allahabad.	Lahore.
Bergholz barograph.	Beckley anemograph.	Draper barograph.
Kew barograph.	Richard barograph.	Richard barograph.
Dines micro barograph.	Richard thermograph.	Casella rain-gauge.
Kew thermograph.	Stokes sunshine recorder.	Beckley anemograph.
Richard thermograph.	Solar radiation thermometer.	Sunshine recorder.
Beckley anemograph.	Grass thermometer.	Grass thermometer.
Dines' pressure tube anemometer.	Ground thermometer.	Nephoscope.
Beckley rain-gauge.	Nephoscope.	Ground thermometer.
Monthly rain-gauge.	Lawrence and Mayo self-recording rain-gauge.	
Hellman Fuess rain-gauge.		
Omori-Ewing seismograph.		
Grass thermometer.		
Ground thermometer.		
Nephoscope.		

7. *The Alipore Observatory.*—This observatory is under the charge of the Meteorologist, Calcutta.

The autographic instruments have on the whole worked satisfactorily during the past year. A Dines' micro barograph was brought into use from 9th February 1915, and the Milne seismograph was changed for an Omori Ewing seismograph in March 1915.

All instruments issued by the Meteorological Department are tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 804 as compared with 768 last year. 35 instruments were condemned as unfit for issue, or were sent to the India Office for repair and 6 instruments were kept in store for future treatment. In addition to the above, 244 instruments were examined and issued to other observatories.

The observatory gives mean Calcutta time to the port and shipping. Three time balls are dropped daily at 1 P.M., local meantime throughout the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore Docks. This work was carried out quite satisfactorily as far as this department is concerned. There were 24 failures as compared with 15, the average number of the past 25 years; but in

all cases they were due to defects in the electric or mechanical arrangements outside the observatory, for which this department is not responsible.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects
1914-1915	24	24
1913-1914	36	36
1912-1913	50	50
1911-1912	21	21
1910-1911	21	20

8. *The Allahabad Observatory.*—This observatory which was under the charge of the Meteorologist Allahabad, was reduced to the status of third class from 9th September 1914, from which date the use of the following instruments (except the nephoscope) was discontinued.

Beckley anemograph.—This instrument worked fairly well while in use, the breaks being due to indistinct tracings and the instrument being out of order.

Richard barograph.—This instrument gave excellent tracings while in use.

Richard thermograph.—The dry bulb tracings with a few exceptions have been good.

Sunshine recorder.—Good results were recorded.

Nephoscope.—Regular observations were made with the Duboscq instrument.

Readings of all the eye instruments were taken every two hours from 8 hours to 18 hours. In addition to the ordinary observations, special observations of cloud for use at the Aerological Observatory at Agra were taken.

9. *The Lahore Observatory.*—Eye observations of the ordinary meteorological instruments were taken seven times daily at this observatory as in past years at 6, 8, 10, 14, 16, 18, and 22 hours. Ground surface temperature was recorded four times daily at 6, 10, 16, and 22 hours.

Character of the work of Observation at second and third class observatories.

10. The general character of the work of the observatories, as judged by the number of mistakes made by observers was satisfactory.

The number of stations of great reliability, in which either no mistake or only one mistake has been detected in the data for the Indian Daily Weather Report, was 21 as against 39 in 1913-14, while, the number of stations at which more than 50 mistakes were made was 5 as against 11 last year.

The usual list showing the number of mistakes in observation and in the preparation of telegrams for all the observatories which send weather telegrams to the Simla office was prepared and circulated to the observatories on the 20th August 1915.

Inspection of Observatories.

11. The number of visits paid to observatories during the year under review was 76 as compared with 69 in the previous year and an average of 60 during the past 10 years.

The Director-General inspected the observatories at Calcutta, Bombay, Alibag, Madras, Kodaikanal, Allahabad, Rangoon and Bangalore. Mr. Normand inspected 16; Mr. Hem Raj inspected 17; Mr. Bion 7; Mr. Gaetane 27 and Mr. V. Daraiswamy Iyer 1.

Of the 69 second or third class observatories that were visited 52 were reported as good, 14 as tolerable and 3 as bad.

Condition.	Second or third class observatories inspected in					
	1914-15.	1913-14.	1912-13.	1911-12.	1910-11.	1909-10.
Good or satisfactory	52	34	31	20	23	25
Tolerable	14	23	17	16	31	11
Bad	3	6	3	1	3	4
Total ..	69	63	51	37	57	40

In estimating the general character of the observatories from the above table it must be remembered that it is, as a rule, on account of something unsatisfactory that a visit of inspection is made. The general level of the stations is thus decidedly better than might otherwise appear. The most frequent cause of bad work is the changing of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments.

Special observations.

12. Observations other than those recorded by local observers at regular intervals are made as follows :—

(*a*) In accordance with orders issued from the Sim'a or Calcutta office, when weather is disturbed and storm warnings may have to be issued : such observations are sent by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Re. 1 for each set of special observations sent under instructions from either Simla or Calcutta. The number of telegrams of the latter class forwarded during the year under review was 401 as compared with 529 despatched the previous year.

(*b*) Certain observers, when they consider that conditions at sea are sufficiently threatening, send of their own initiative to Simla or Calcutta a telegram containing special observations. Nine such telegrams were received.

(*c*) In connection with flood warning a number of observers have been instructed to send the telegrams announcing the occurrence of heavy rainfall to Government officers and railway engineers who desire early information. The number of telegrams so sent was 207 as compared with 126 last year.

(*d*) Observers are instructed to send detailed information of earthquakes to the Simla Meteorological Office and to the Director, Geological Survey, Calcutta ; for this work they are paid awards from this department. Of such reports 104 were received during the year.

Observations with special Meteorological Instruments.

13. The following special observations were carried out during the past year at certain selected stations :—

1st—Wind observations recorded by Beckley anemographs at 8 stations, and by Dines' pressure tube anemometers at 4 stations.

2nd—Solar and terrestrial radiation observations at 2 and 9 stations, respectively.

3rd—Underground temperature observations at 2 stations.

4th—Sunshine observations at 6 stations.

5th—Barometric observations recorded by self-registering instruments, chiefly Richard barographs at 18 stations.

6th—Temperature observations recorded by self-registering instruments, chiefly Richard thermographs, at 10 stations.

Observations of solar energy in absolute units.

14. Observations were continued at Simla throughout the year, when weather conditions allowed, by means of Angstrom's electric pyrheliometer.

Observations in the Upper Air.

15. Until the beginning of July 1914, by which time the new observatory buildings in Agra were sufficiently near completion to be occupied, work was continued at the temporary quarters secured last year. The new buildings were occupied at the beginning of July and work was begun on their equipment. By the end of the year the internal arrangements were nearly ready for full activity.

Pilot balloons were sent up during the year at Agra and Simla, and cloud observations and measurements were made three times daily at several stations in India. In April 1914 a new pilot balloon station was started at Kojak (Chaman), and special short series of balloon observations were made at Darjiling from April to June and at Allahabad in May and June.

The major portion of the year 1914-15 was thus occupied with experimental work and preparations for its extension, but some progress was made in the analysis of balloon and cloud observations. The results in India of balloon flights were supplied to Dr. Fillippi over the period covered by his similar work in the Himalayas; and a discussion of cloud observations made by the Survey Department in the Pamirs was contributed to their report of a journey in that region.

Researches by the Simla Staff.

16. Owing to the transfer of the laboratory and mechanics from Simla to Agra the opportunities for experimental research in Simla have become very greatly reduced and no experimental work is at present being undertaken in Simla. Research work of a statistical nature, however, continues and during the year a long investigation with the object of correlating weather in all parts of the world with solar activity as exhibited by sunspots has been successfully completed. The results are published in the Memoirs of the Department.

It was mentioned in last year's report that the problem of forecasting the local distribution of monsoon rainfall was being undertaken. This work necessitates the preparation of large masses of statistics and their mathematical investigation. Satisfactory progress has been made, but the investigation is not yet completed.

Seismograph Observations.

17. Seismological observations were recorded throughout the year by two Omori-Ewing seismographs at Simla and one at Bombay; by Milne seismographs at Alipore (Calcutta), Kodaikanal and Colaba (Bombay); and by means of other self-registering instruments at the last-named station. The Milne seismograph at Alipore was dismantled on 20th December 1914 and one by Omori-Ewing was brought into use on 17th March 1915. All the instruments worked satisfactorily throughout the year, and copies of the records of the Milne seismographs were transmitted to the Seismological Committee of the British Association.

Marine Meteorology.

18. No change was made during the year under review in the method of collecting marine information.

At Calcutta and Bombay a clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard, for the purpose of applying the necessary corrections to the readings in the logs; and, after the barometer comparisons have been made a statement of the error of the ship's barometer is given to the captain, in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port, but it is ample for the purposes of the department.

The data thus obtained are utilised in the preparation of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department, and in drawing up an account of the storms of the year for publication in the Annual Summary.

The arrangements made with the London Meteorological Office, and the Royal Alfred Observatory at Mauritius, for collecting marine data from the whole of the Indian Ocean, have

been continued and the thanks of this department are again due to these offices for thus supplying a large amount of useful data.

Observations recorded during the year at the entrance of the River Hughli were supplied to the Meteorological Department by the light-vessel "Luna."

Snowfall Registration in the Mountain Districts to the North and West of India.

19. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete, and the thanks of the department are again due to the various officers who have collected and forwarded it. Additions to the information received have been obtained by continuing the series of large-scale photographs of the snows, as seen from Simla, which was started in 1905.

Rainfall Registration.

20. The registration of rainfall in India has invariably been carried out by the provincial authorities. In 1889 a uniform system was introduced by the Government of India, and the Director-General of Observatories was made consulting officer in connection with this work. His advice is sought regarding the starting of new rain-gauge stations, and he receives annual reports from the local officers responsible for the registration of rainfall upon the efficiency of the work. A general account of the system, which came into operation in the year 1891-92, will be found on pages 5-8 of the Administration Report of the year 1889-90, and on pages 6 and 7 of the Administration Report for the year 1890-91.

The following is a statement of the number of rain-gauge stations from which data were being received for publication in the Rainfall Data of India at the end of the year under review :—

Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1915.	Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1915.
Burma	211	Baluchistan	93
Assam	124	Rajputana	186
Bengal	223	Bombay and Sind	289
Bihar and Orissa	294	Central India	117
United Provinces	276	Central Provinces	178
Punjab	189	Hyderabad	18
Kashmir	37	Mysore	77
North-West Frontier Province ..	33	Madras (including Pudukkottai, Coorg, Travancore and Cochin).	506

The following paragraphs give a brief summary of the reports of the officers in charge of rainfall registration for the year 1914-15 :—

Assam.—The total number of rainfall stations was 124 against 125 in the preceding year. The number of gauges inspected was 92, or one more than the previous year, the total number of inspections being 167 against 133 the previous year. In Cachar more than half the gauges remained without inspection owing to the resettlement of the district. Inspections of 57 rain-gauges were made more than once.

Baluchistan.—There were at the close of the year 92 rain-gauges : of these 45 were maintained by the railway department at railway stations, while 38 (excluding those attached to departmental observatories) were under the civil and irrigation departments.

No mention is made by the Revenue Commissioner in Baluchistan of the number of rain-gauges inspected, it being only remarked that no special points were brought out by the inspection of gauges.

Bihar and Orissa.—The total number of rain registering stations amounted to 294 (including 26 stations situated in the Orissa Feudatory States and Orissa Tributary Mahals) against 282 last year. Inspections of 155 stations were made and 99 inspection cards were received against 150 and 111 respectively last year. The rain-gauges were, on the whole, in good condition, and the work of registration was done satisfactorily.

Bengal.—There were 224 rainfall stations in the Province or one less than last year. Of these, only 32 were inspected as against 48, 60, and 108 during each of the preceding years. These figures show that there has been a steady slackening in the work of inspection in Bengal and the matter has been brought to the notice of the Director of Agriculture, Bengal, under whose supervision the work is done.

Bombay and Sind.—There were 278 rain-gauges in British districts against 276 in the previous year, of which 207 were inspected as compared with 213 last year. The total number of inspections amounted to 324 against 355 last year and 87 gauges were inspected more than once. There was some improvement with respect to the work in Native States, in that 46 gauges (out of 61) were inspected as compared with 38 inspected the previous year, four gauges being inspected more than once.

Burma.—There were 211 rain recording stations as against 200 the previous year: of these 19 were meteorological observatories and 26 in charge of the Public Works Department. Inspections of 140 rain-gauges were made, or a decrease of 16 as compared with last year. Of these 106 were reported in good, 28 in a fair, and 6 in a bad state.

Central Provinces.—The number of rain-gauges maintained during the year was 118 against 112 in the previous year. The number of inspections of which reports were received was 130 against 121 in the preceding year. The results obtained during the year were generally satisfactory.

Hyderabad.—The rainfall registering stations of Hyderabad are in charge of the Nizam's Public Works Department. There are 16 such stations, all of which have been inspected and 8 have been visited more than once. In addition, there is a rain-gauge at the Residency Hospital in charge of the Residency Surgeon.

Kashmir.—There were 36 rain-gauges in this State, of which 8 are meteorological observatories and the remainder are in charge of the Revenue Department. Only two gauges were inspected owing to epidemic diseases which prevailed in the State.

Madras.—There were 477 rain recording stations at the close of the year under review, of which 394 were in the Madras Presidency: in the preceding year the corresponding figures were 475 and 391. The number of stations inspected was 388 as against 377 inspected the previous year.

Mysore.—At the close of the calendar year 1914 the number of rain recording stations was 225 as against 223 in the previous year. Out of these, 194 or 86 per cent. were inspected as against 87 per cent. during the previous year.

North-West Frontier Province.—The report on rainfall registration contained in the current administration report of this province refers to the year 1913-14 and states that the rain-gauges were in good order and the rainfall registers well kept. Two new rain-gauges were established in the Dera Ismail Khan District, one at Miran and the other at Chandhwan.

Punjab.—The number of rain-gauges in the Punjab during the calendar year 1914 was 231 or 9 more than last year. Of these, 153 were in charge of district officers and 78 under canal officers. There were 55 inspections during the year as against 51 last year. The rain-gauges under both district and canal officers are reported to be in good order and the records well kept up.

United Provinces.—There were 288 rain reporting stations in these provinces including the meteorological observatories. Out of 274 stations under the supervision of district and canal officers, 58 per cent. were inspected during the year.

Summary.—In the Central Provinces, Hyderabad, Madras, and Mysore over 75 per cent. of the rainfall stations were inspected; in Assam, Bihar, Bombay, Burma, and the United Provinces over 50 per cent.; Bengal 14 per cent.; Kashmir 5 per cent.; and the Punjab 23 per cent.

The System for Storm Warning.

21. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed from the Simla Office by the Director-General of Observatories, and from the Calcutta office by the Meteorologist, Calcutta.

The following ports are warned from Simla for storms in the Arabian Sea:—

Aden, Karachi, Cutch Mandvi, Jamnagar, Dwarka, Porbandar, Veraval, Jafarabad, Bhavnagar, Daman, Bombay, Alibagh, Murud Janjira, Harnai, Ratnagiri, Malvan, Vengurla, Nova Goa, Marmagao, Karwar, Kumta, Honavar, Mangalore, Tellicherry, Calicut, Cochin, Alleppy and Colombo.

The Meteorologist, Calcutta, warns the following ports for storms in the Bay of Bengal:—

Colombo, Tuticorin, Pamban, Nagapatam, Cuddalore, Madras, Masulipatam, Cocanada, Vizagapatam, Calingapatam, Gopalpur, Puri, Hukitala (False Point), Chandbali, Balasore,

Saugor Island, Diamond Harbour, Mud Point, Budge Budge, Calcutta, Morelganj Barisal, Goalundo, Narayanganj, Noakhali, Chittagong, Cox's Bazar, Akyab, Kyaukpyu, Diamond Island, Bassein, Rangoon, Moulmein, Tavoy, Mergui, Table Island and Port Blair.

The following River Police stations in Eastern Bengal and Sunderbans have been added :—

Markholi, Mudna, Nikli, Bhairab, Jaikalipur, Dandkandi, Narayanganj, Goalundo, Lohajang, Chandpur, Elashin, Patuakhali, Hargilarchar, Sirajganj, Jhalakati, and Pirojpur.

22. In addition to special messages sent during stormy weather the Meteorologist, Calcutta, provides shipping during a large part of the year with daily information regarding the weather over the Bay. This information is made available at the following places by means of daily weather telegrams to an officer at the Port or by the hoisting of flag signals :—

Negapatam, Porto Novo, Cuddalore, Madras, Cocanada, Vizagapatam, Calingapatam, Gopalpur, Saugor Island, Chittagong, Akyab, Elephant Point, Rangoon, and Moulmein. Information to Kalagauk and Sabang was discontinued during the year.

23. In accordance with resolutions passed at the International Radio-Telegraph Conference held in London in June and July 1912, the Indian radio-telegraph coast stations are now supplied with telegrams containing meteorological information with regard to the Arabian Sea and the Bay of Bengal for transmission to ships which ask for them. These messages are sent to the radio stations at Bombay, Karachi, Sandheads, Diamond Island, Table Island and Victoria Point. The messages to the Calcutta radio station were discontinued in January 1915.

Arrangements made for the receipt by wireless telegraphy of meteorological observations from ships at sea worked satisfactorily up to August, when owing to the outbreak of the war these wireless telegrams had to be discontinued.

Warnings for Storms in the Bay of Bengal.

24. During the year warnings were issued for thirteen disturbances. Four of these developed into storms of some severity and were of sufficient importance for a statement to be given here of their course and of the action taken.

(1) A depression formed to the west of the Andamans on the 12th May. It developed during the next two days into a storm of considerable intensity, and travelling in a north-westerly direction crossed the coast just south of Gopalpur on the night of the 15th.

The Bay ports that were likely to be affected or from which ships might run into the storm were informed daily from the 12th. On the 14th the Orissa and north Madras coast ports were warned of the approach of the storm and suitable signals were hoisted. The action taken with regard to Gopalpur is shown by the following telegrams :—

Gopalpur.

14th May 1914 at 11 hrs. 55 mins. "Hoist danger signal number three.* A severe cyclonic storm is advancing towards north Circars or Orissa coast."

15th May 1914 at 11 hrs. 16 mins. "Storm probably very severe about one hundred miles south-east of Gopalpur approaching that port; take precautions."

16th May 1914 at 11 hrs. "Lower storm signal; storm passed inland near Gopalpur last night, now moving north or north east."

The storm at first appeared to be travelling north or north-east, and only the ports on the east of the Bay were warned until the 14th, when it was ascertained that the storm was moving in a north-westerly direction.

(2) On the 31st May a storm was shown forming over the north of the Bay. It developed into a severe disturbance, and may even have been a true cyclone with a calm centre. On the 2nd it was in Lat. 18½°, Long. 89°, and then travelled in an east-north-easterly direction (an unusual course for a storm in May or June) and crossed the coast to the south of Akyab on the evening of the 3rd.

On the 31st ports on the south Orissa and north Madras coasts were warned that a storm was forming off the north Circars coast, and on the 1st all ports west of Noakhali were told that the storm was moving north or north-east. On the early

* Indicating that a cyclonic storm, probably of slight to moderate intensity, is affecting the port, and that its centre will probably cross the coast over or near to the port.

morning of the 3rd when it was definitely ascertained that the storm was travelling in an easterly direction the ports on the southeast Bengal and Arakan coasts were informed that the storm was approaching the Arakan coast near Akyab. The action taken with regard to Akyab is shown by the following telegrams :—

AKYAB.

3rd June 1914 at 5 hrs. 26 mins. "Hoist warning signal.* Storm from Bay approaching the Arakan coast near Akyab."

3rd June 1914 at 10 hrs. 27 mins. "Hoist great danger signal number three.† Storm in the Bay has become a severe cyclone and is advancing towards Akyab. Take all precautions in port."

3rd June 1914 at 18 hrs. "Lower storm signal. Storm crossed coast near Akyab."

(3) A depression formed over the Andaman Sea on the 1st October, travelled north-westwards on the 2nd and 3rd, and then changing its course to north and north-east crossed the coast midway between Chittagong and Akyab on the 6th. It was a disturbance of moderate intensity.

The Andamans and the ports on the neighbouring Burma coast were informed of the existence of the storm on the 2nd, and warnings were extended on 3rd to the Arakan coast. On the 5th intimation of the approach of the storm was sent to Chittagong and the other ports on the east Bengal coast.

The action taken with regard to Akyab and Chittagong is shown by the following telegrams :—

AKYAB.

3rd October 1914 at 11 hrs. 10 mins. "Depression exists west of Andamans expected to develop into storm."

4th October 1914 at 11 hrs. 55 mins. "Hoist warning signal. Depression become storm about one hundred fifty miles west Diamond Island may move north-east affecting Akyab."

5th October 1914 at 10 hrs. 5 mins. "Lower warning signal and hoist danger signal number three. Storm intensified appears to be moving towards coast near Akyab. Take precautions."

5th October 1914 at 15 hrs. 40 mins. "Storm moving north unlikely to affect you further."

6th October 1914 at 11 hrs. 2 mins. "Lower storm signal. Storm reduced intensity now south of Noakhali moving north."

6th October 1914 at 23 hrs. 13 mins. "Storm passed inland and filled up."

CHITTAGONG.

5th October 1914 at 11 hrs. 2 mins. "Hoist warning signal. Storm exists considerable distance south-west Kyaukpyu moving northerly direction."

6th October 1914 at 10 hrs. 52 mins. "Lower warning signal and hoist danger signal number three. Storm reduced intensity now south of Noakhali moving north."

6th October 1914 at 22 hrs. 25 mins. "Lower storm signal. Storm passed inland and filled up."

(4) Weather was disturbed over the south of the Bay on the 16th and 17th December and by the morning of the 18th these disturbed conditions had developed into a storm situated about 100 miles to the east of Trincomalee. Its position on the morning of the 20th was about Long. $84\frac{1}{2}°$ and Lat. $12\frac{1}{4}°$, and from this position it followed a north-easterly course till it crossed the coast close to Akyab on the night of the 21st-22nd. The storm was one of considerable intensity.

The Andamans and the ports on the Coromandel coast were informed on the 18th of the formation of a disturbance which might move towards the Madras coast. As the storm appeared to be changing its course to north warnings were extended on the 19th to Masulipatam and Cocanada, on the 20th to Vizagapatam, Calingapatam, Gopalpur, Puri and Hukitala, and on the 21st to the ports between Chandbali

*Indicating that a cyclonic storm has formed, which will probably advance to that part of the coast on which the port is situated, but is still at a considerable distance from it.

†Indicating that a cyclonic storm of great intensity is affecting the port, and that its centre will probably cross the coast over or near to the port.

and Kyaukpyu. The evidence afforded by the observations was so conflicting that it was not till the afternoon of the 21st that the ports concerned could be told definitely that the storm was advancing towards the Chittagong coast.

The following telegrams show the action taken with regard to the ports of Chittagong and Akyab :—

CHITTAGONG.

21st December 1914 at 12 hrs. 6 mins. "Hoist warning signal. Storm in Bay there is possibility of reaching you within twenty-four hours cannot say definitely yet but will wire again."

21st December 1914 at 15 hrs. 43 mins. "Hoist great danger signal number three storm curving eastwards will strike coast to-night probably between Saugor Island and Akyab."

21st December 1914 at 19 hrs. 29 mins. "Storm moving towards Chittagong will cross coast to-night. Intensity probably decreasing."

22nd December 1914 at 6 hrs. 42 mins. "Lower storm signal. Storm has crossed coast between Cox's Bazar and Akyab."

AKYAB.

21st December 1914 at 15 hrs. 43 mins. "Hoist great danger signal number three. Storm curving eastwards will strike coast to-night probably between Saugor Island and Akyab."

21st December 1914 at 19 hrs. 29 mins. "Storm moving towards Chittagong will cross coast to-night. Intensity probably decreasing."

22nd December 1914 at 6 hrs. 42 mins. "Lower storm signal. Storm has crossed coast between Cox's Bazar and Akyab."

WARNING FOR STORMS IN THE ARABIAN SEA DURING THE YEAR.

25. The Simla office warns the west coast ports, not only for storms, but also for squally weather, especially at the beginning of the monsoon. There were eleven periods of disturbed weather in the Arabian Sea, for which warnings were issued, but none of these disturbances developed into a storm.

FLOOD WARNINGS AND WEATHER FORECASTS TO DISTRICT, IRRIGATION, RAILWAY AND OTHER OFFICERS.

26. This work is carried out chiefly by the Simla Meteorological Office, and partly by that of Calcutta. The arrangements have been made at various times, and differ considerably in character, according to the nature and extent of the flood or weather warnings required by the officers concerned. In most cases these officers require telegrams warning them of advancing storms likely to give heavy rain, or of actual heavy rainfall, likely to give rise to severe floods which might injure railways or canal works; and in others they require warnings or forecasts of the weather for as long a period beforehand as possible, so as to enable them to modify their arrangements for carrying on the works under their charge so far as may be necessitated by sudden or large changes of weather.

The number of district officers and officers in the irrigation, telegraph, railway and other departments requiring warnings from Simla amounted at the end of the year to 146, an increase of 14 during the year.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Karachi, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

27. The number of warning messages sent from Simla during the year 1914-15 was 2,060 as compared with 1,840 in 1913-14 and 1826 in 1912-13. The number for 1914-15 includes 203 daily messages sent to the Director of Marine, Bombay, regarding atmospherics in the Arabian Sea.

The number of warnings for heavy rainfall sent from Calcutta during the year 1914-15 was 1,003 as compared with 863* in 1913-14.

* The number given in last year's "Administration Report" was not correct.

28. Instructions were issued by the Government of India in 1898 that every officer to whom storm or flood warnings are issued, should in the month of January of each year or, in the case of military expeditions, at the close of the campaign, forward to the head of this department a brief return of the warnings received during the past year, and should also report :—

(1) Whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

(2) Whether the warnings were timely and satisfactory in every respect and, if not, in what points they were defective.

(3) Whether any changes might be made in the system which would make the warnings more useful.

Reports on the ordinary storm and flood warnings for the calender year 1914 were received from 52 officers. Of these 35 stated that the warnings were satisfactory; 13 offered no remarks, and 3 reported that they had received no warnings during the year, while one stated that a warning had been received too late to enable him to take full precautions.

The following extracts from letters received may be of interest :—

From the Superintending Engineer, Public Works Department, Bengal, South-Western Circle. " I should like to take this opportunity of expressing my obligation to the Meteorological Department for the help they have extended to this Department during the flood season of 1914, more especially in connection with the new system of flood warnings introduced for the first time during that year in connection with the Damodar floods. The telegrams received from specially selected rainfall stations in Chota Nagpore were of great assistance. They were despatched and received promptly and enabled the warnings of floods to reach the officers in charge of the embankments well in advance of the floods. Since everything worked so well I am unable to suggest any modifications and I hope the same system will be continued this year."

From the Director of the Royal Indian Marine, " Telegrams regarding atmospherics are no longer necessary now that the situation in these waters has eased. These telegrams have been of great assistance to me in connection with Wireless Telegraph operations."

From the Executive Engineer, Terai and Bhaber Government Estates Division. " The construction of the arch for which the information was required has been finished, and owing to the notice we have had of sudden freshets from the Kumaon hills the difficulties were considerably reduced."

From the India General Navigation and Railway Company, Limited. " Our Narainganj Agent has forwarded us copies of your telegrapic warnings regarding the movements of the recent cyclonic storm. These have been of the greatest assistance to us in the protection of our numerous vessels plying within the disturbed area and we beg to tender our thanks for the very complete record of the movements of the disturbance communicated to our various Agencies."

A comparison of the reports of floods and of heavy rain with information supplied to the various officers would appear to show that the system is working satisfactorily, and that most of the warnings issued were timely and of use to the recipients. No suggestions were put forward by the officers concerned for changes or improvements in the flood warning service.

Seasonal Forecasts.

29. The forecast for the monsoon period of 1914 dated the 8th June, was sent to Local Governments and Administrations, communicated to the press, and printed in the Gazette. A statement of the rainfall of June and July with a forecast for August and September was drawn up on the 8th August 1914 and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was drawn up on the 4th January 1915, and sent to Local Governments and Administrations.

The following are summaries of these two forecasts, and a comparison of them with the actual rainfall:—

Forecast dated 8th June 1914.	Remarks.
(*a*) The indications are conflicting, but it appears on the whole likely that the total monsoon rainfall of India will be somewhat less abundant than usual, at any rate in the earlier part of the season.	The monsoon rainfall of India was less than usual in June, for the total rainfall of that month which was almost exactly normal, included an unusually large quantity of rain in the extreme north brought by depressions of the cold weather type entering India through Afghanistan or Western Turkistan. In August also the rains were less abundant than usual, but in July and September there was an excess, and the total rainfall of the season was in excess by 3·4 inches or 10 per cent.
(*b*) There are indications of unsteadiness, so that periods of abundant as well as of scanty rainfall are to be expected.	The monsoon was abnormally unsteady in June, August and September.
(*c*) Regarding the geographical distribution of rainfall it seems that while local conditions are favourable for the Malabar coast they are somewhat unfavourable for the Punjab and United Provinces, and, to a very slight extent, for Rajputana and Central India. These indications regarding distribution apply only to the first half of the monsoon period.	The total rainfall of June and July in Malabar was in excess by 3½ inches or 5 per cent., and the excess extended to the Konkan, Bombay Deccan and Hyderabad. As regards the Punjab and United Provinces, if we reckon rainfall from the 12th June, before which date the monsoon had not reached these areas, the rainfall of the Punjab was in defect until the middle of July, and that in the west of the United Provinces until August, but that in the east reached its average total early in July. The monsoon rainfall of Rajputana similarly estimated was in defect until the middle of July and that of Central India in June.

Forecast dated 8th August 1914.	Remarks.
(*a*) The indications regarding the total monsoon rainfall of August and September are decidedly conflicting. On the whole it appears probable that the rainfall will be roughly normal in amount.	The rainfall of India was in slight defect in August and in slight excess in September; the total for the two months was in excess by 0·27 inch or 2 per cent., which is practically normal.
(*b*) There are signs of greater variability than usual in the strength of the monsoon.	The monsoon was abnormally unsteady in August and September.
(*c*) There are no reasons for anticipating any marked abnormalities in the geographical distribution of rainfall.	These abnormalities occurred to about the usual extent. Rainfall was in defect in Central India and in excess in the Peninsula excluding Mysore.

The August forecast was correct in its main features, but the indications of that of June were too pessimistic regarding the rainfall of the first half of the period, especially in July. The forecast was based on the view that pressure would be unfavourable and those of June and July actually proved to be such as are usually associated with deficient monsoon rains. The partial failure of the forecast in its indications regarding the United Provinces and surrounding areas in July is thus due to some factor about which nothing is known as yet.

30. A forecast of the probable character of the rains during January and February 1915 was prepared on the 6th January 1915 and issued in the same manner as the forecast of the previous June. On the 14th July 1915 a comparison of the actual precipitation with the above forecast was issued.

The summary of the forecast issued was :—

It is probable that the amount of rainfall in north-west India and of snowfall on the neighbouring hills will be approximately normal.

The snowfall was practically normal. The rainfall was deficient in north-west India during January by ·12″ and in excess during February by ·91″ : thus over the whole period there was an excess of ·79″. The excess during February was chiefly due to disturbance in the first week which gave some unusually heavy local rain, especially in Rajputana and the United Provinces. Judged by the character of the weather and not by the total rainfall the season was not abnormal.

Daily Telegraphic Weather Summary.

31. The summary was despatched daily at about noon. It was exhibited at certain telegraph offices and sent to 102 officers of Government. The subscribers, for longer or shorter periods, were 18 newspapers and 41 private individuals.

Publications.

32. There were no changes made during the year in the routine publications of the department of which a description will be found in the departmental Administration Reports of 1907-08 and 1910-11.

The following memoirs of the Indian Meteorological Department were published during the year 1914-15 :—

" A further study of relationships with Indian Monsoon Rainfall ; " by Gilbert T. Walker, C.S.I., M.A., Sc.D., F.R.S., Director General of Observatories. (Memoirs of the Indian Meteorological Department, Volume XXI, Part VIII.)

" Correlation in seasonal variations of weather, III on the criterion for the reality of relationships or periodicities ;" by Gilbert T. Walker, C.S.I., M.A., Sc.D., F.R.S., Director General of Observatories. (Memoirs of the Indian Meteorological Department, Volume XXI, Part IX.)

" Monthly and annual normals of pressure, temperature, relative humidity, vapour tension and cloud ; " by Gilbert T. Walker, C.S.I., M.A., Sc.D., F.R.S., Director General of Observatories. (Memoirs of the Indian Meteorological Department, Volume XXII, Part III.)

" A discussion of the anemographic observations recorded at Port Blair and Dhubri ;" by W. A. Harwood, M.Sc., Assistant Director, Aerological Observatory, Agra, with an introduction by Gilbert T. Walker, C.S.I., M.A., Sc.D., F.R.S., Director General of Observatories. (Memoirs of the Indian Meteorological Department, Volume XIX, Parts III and IV.)

Supply of Meteorological information.

33. In addition to the meteorological information published by the department special information was supplied to the Meteorological Departments of England, Australia and Egypt, and to the Solar Physics Committee, London.

Climatological information, at times involving special calculation, is also provided for sanitary and other officers of Government, as well as for private firms who are willing to pay the expense necessarily incurred. The extent to which the department is utilised in this manner is increasing steadily, as will be seen from the chart appended.

Miscellaneous.

34. Seven hundred and forty-eight books and pamphlets, either purchased or presented by scientific bodies were added to the Library during the year, as against eight hundred and seventy-seven in the previous year. The cause of the reduction is attributable to the war.

Nine libraries, observatories or societies were added during the year to the list of institutions to which the publications of the Indian Meteorological Department are supplied, and four were removed ; the number on the list is now 347.

CHIEF FEATURES OF THE YEAR.

35. At the end of the previous year arrangements had been completed for obtaining from ships at sea information by wireless telegraphy as to the meteorological conditions experienced by them. This information is of the greatest importance in fixing the intensity and position of storms before the coast stations are sufficiently affected for reliable inferences to be drawn from their observations. Unfortunately before the new scheme had been sufficiently long in use to ensure smooth working the war put an end to wireless communication, and the scheme was in abeyance during the remainder of the year under review.

The negotiations connected with the reorganisation of the system of storm warnings in the Bay of Bengal and Arabian Sea, and for distributing information to ports and shipping with regard to daily weather were continued. The opinions of those chiefly affected have been collected and discussed, and before the end of the year the final scheme was submitted to Government for approval.

The warning of ships and ports, which is one of the chief functions of the department, has also been developed on its scientific side. Mr. Peake, who during many years has gained valuable experience as the officer in charge of the Bay of Bengal storm warning service in Calcutta came to Simla on deputation from 1st July to 30th October 1914 and devoted his whole time to a study of the origin and development of the storms in the Bay. His attention was given chiefly to devising methods for fixing with greater accuracy the positions of the storms, and for determining their movement from the successive changes in the meteorological elements at the coast stations. The work, which necessitated consulting the records of previous storms, has given valuable results and a *resumé* will shortly be published in the Memoirs of the Department. It is difficult to overestimate the benefits derived from deputations of this nature. In addition to the direct results of solving difficult problems the intercourse which such investigations necessitate between the scientific officers of the department has a great stimulating effect.

It is a well-known fact that it is the unsteadiness of the atmosphere and not the power of the telescope which ultimately limits the possibility of seeing the finest details of the heavenly bodies. In 1913 Mr. Evershed, the Director of the Solar Observatory at Kodaikanal spent his privilege leave in Kashmir, and while there he was very much struck by the great homogeneity of the atmosphere which made it possible to see the surface structure of the sun and planets with extraordinary distinctness. Solar work depends so largely on the ability for seeing the finest markings of the sun's surface, that the Government of India deputed Mr. Evershed to visit Kashmir during May to July 1914 to carry out further investigations on this unexpected quality of the atmosphere over the Kashmir valley. The photographs of the sun taken on this expedition, and the careful record kept of the "seeing" at all hours of the day, have proved conclusively that so far as is known, no other place in the world can compare with Kashmir in this respect. The discovery is so important that a further expedition to Kashmir with more powerful instruments and for a longer period has been sanctioned and will take place during 1915-16.

At the time of his death, Sir John Eliot was engaged on writing a series of memoirs on the winds of India, based on the data accumulated during a large number of years from Beckley anemometers. He had already discussed the records from eleven stations and left the tabulated data for six other stations. These latter data have now been discussed by Mr. Harwood and the results published, thus completing the work commenced by Sir John Eliot.

On 9th September 1914 the observatory at Allahabad was reduced to third class. This step was taken in view of the fact that during the 49 years that the observatory has been in existence sufficient data have been obtained to give complete knowledge of the climatology of the district. The third class observatory will give all the information necessary for weather changes from day to day, and the reduction has made it possible to employ the staff of the observatory on more useful work in connexion with the investigation of the upper air at Agra.

Strenuous work by Mr. Field and his staff at Agra has resulted in the Aerological Observatory being fully equipped, and the observational and experimental work connected with the investigation of the upper air is now in full swing.

An important change in the internal administration of the department was effected during the year in consequence of which the work connected with the accounts of the department has been transferred from the Calcutta to the Simla office.

Concluding Remarks.

36. The Meteorological Department owes a large part of its usefulness to the sympathetic assistance it receives from outside departments. Civil Surgeons and other officers of Government departments, as unpaid superintendents of observatories and in other capacities, help in the meteorological work; the Telegraph and Postal Departments assist in every way in the rapid transmission of meteorological information, at the same time that they allow their employees to act as observers. The Eastern Telegraph Department, by transmitting the daily Aden message free, and the Indo-European Telegraph Company by giving free transit to the daily records of the Persian observatories, place a large volume of most valuable information at the disposal of the Meteorological Department.

Weekly telegrams were received from the 1st May to the 15th October from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams gave valuable information of the weather conditions in the Indian Ocean and the Department is indebted to the officers indicated for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the Indian Meteorological Department.

The Department is greatly indebted for important information as to meteorological conditions prevailing antecedent to and during the south-west monsoon, to the Director, Agriculture and Forestry Department, Zomba, British Central Africa; the Meteorologist, Dar-es-Salaam; His Majesty's Commissioner, Entebbe, Uganda; the Director, Physical Services, Survey Department, Cairo; the Commonwealth Meteorologist, Melbourne; the Directors of the Observatories at Buenos Ayres and Santiago; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

The central office of the Meteorological Department at Simla was under the charge of Dr. Walker and the general administration of the Department was in his hands, while the local officers who have helped very materially with the current work of the Department were as follows:—Calcutta, Mr. C. W. Peake and Dr. E. P. Harrison; Madras, Mr. R. Ll. Jones; Bombay, Mr. G. W. Talbot and Mr. W. P. Henderson; and Allahabad, Dr. E. G. Hill and Mr. A. P. Sircar.

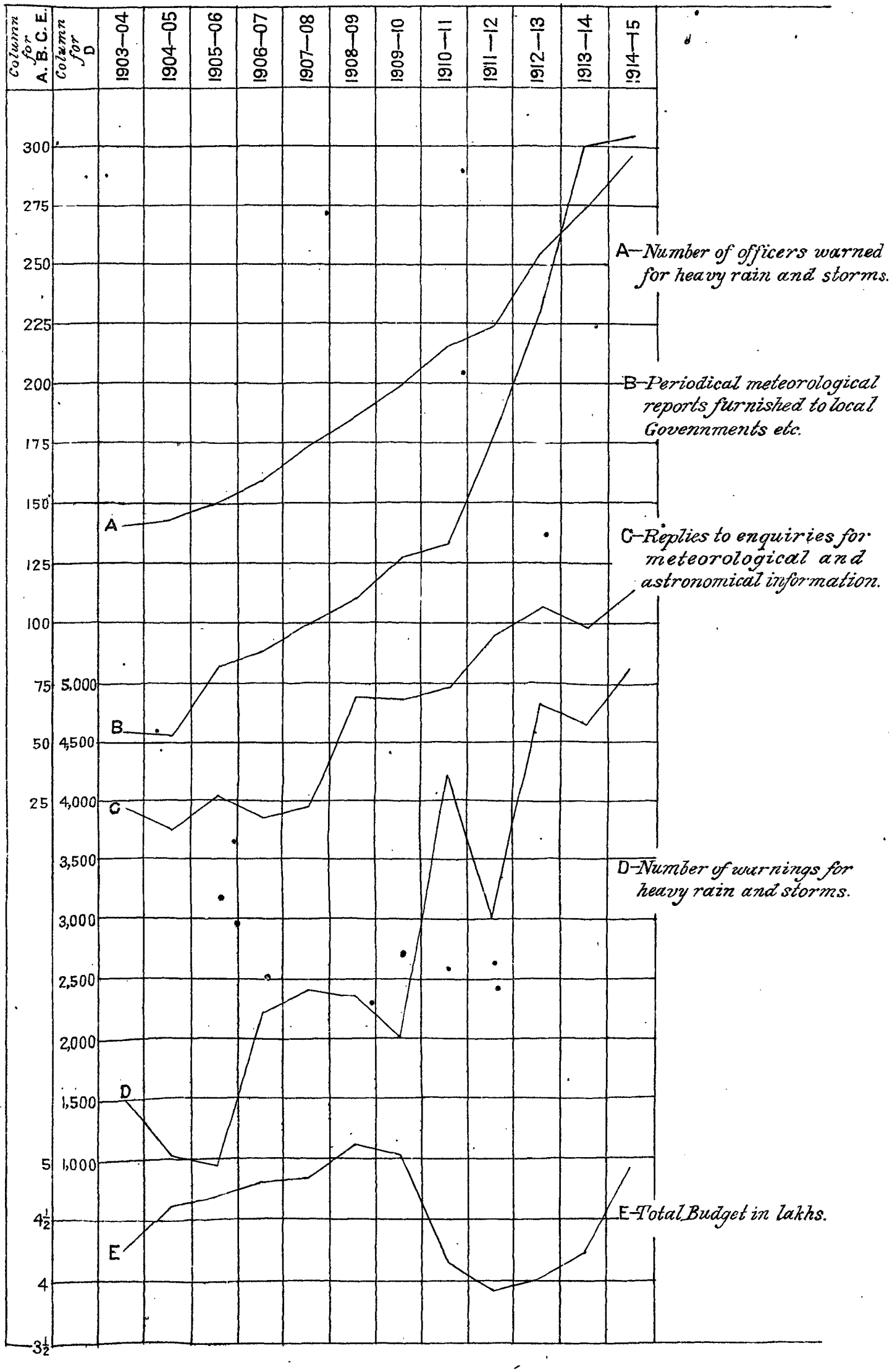
GEORGE C. SIMPSON,

Offg. Director-General of Observatories.

Simla, the 8th September 1915.

G. M. Press, Simla.—No. 1DGofO—30-9-15.—290—M.D., etc

DIAGRAM SHOWING GROWTH IN DEPARTMENTAL ACTIVITY AND CHANGES IN TOTAL COST



REPORT ON THE ADMINISTRATION OF THE METEOROLOGICAL DEPARTMENT OF THE GOVERNMENT OF INDIA IN 1915-16.

CHANGES IN THE STAFF DURING THE YEAR.

Dr. Gilbert T. Walker was on combined leave from the 18th March 1915 to the 7th November 1915. Dr. G. C. Simpson acted for him.

Dr. G. C. Simpson was placed at the disposal of the Army Department for service as a Meteorologist in Mesopotamia from the 25th March to the 25th May 1916.

Mr. C. W. B. Normand was appointed to the Indian Army Reserve of Officers with effect from the 29th February 1916.

Mr. W. A. Harwood was on medical leave for 21 days from the 1st July to the 21st July 1915. He was appointed to the Indian Army Reserve of Officers with effect from the 10th February 1916.

Rai Bahadur Hem Raj was on privilege leave from the 10th January to the 4th March 1916. Mr. Bion acted.

Dr. E. P. Harrison, Professor, Presidency College, Calcutta, was placed on special duty in the Simla Meteorological Office for four months from the 1st July 1915, but he was appointed to the Indian Army Reserve of Officers from the 30th July 1915.

Dr. T. Royds was on special leave from the 1st March 1915 to the 29th May 1915 in continuation of privilege leave. Mr. S. Sitarama Aiyar acted.

Dr. N. A. F. Moos was on privilege leave from the 31st January to the 30th April 1915. Mr. Mukandrai Virshunker Unaker acted.

Mr. W. P. Henderson was Meteorologist, Bombay, until the 30th April 1915 and was then succeeded by Mr. C. D. deV. Babington.

Dr. E. G. Hill was on leave for 2 months and 24 days from the 21st April to the 14th July 1915. Mr. A. P. Sircar acted. The post of Meteorologist, Allahabad, was abolished from the 1st August 1915.

OBSERVATORIES.

2. The observatories maintained by the Government of India are classified as follows :—

First Class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, and wind direction and velocity, in addition to instruments read by eye.

Second Class.—Observatories at which readings are taken daily at 8 hrs., 10 hrs., and 16 hrs.: those at 8 hrs. are (with a few exceptions) transmitted by telegram to one or more of the offices at Simla, Calcutta, Bombay and Madras for inclusion in India or Provincial Daily Weather Reports.

Third Class.—Observatories—

(*a*) where readings are taken daily at 8 hrs. only; at those stations where there are telegraph offices the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports;

(*b*) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determination of monthly and daily means which should be comparable with the means already obtained for second class observatories.

Fourth Class.—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only are recorded.

Fifth Class.—Observatories which telegraph rainfall only.

3. At the end of the year the total number of observatories was 274 of which 41 were non-departmental and 233 were maintained by the Government of India. Of the 233 departmental observatories, 5 were first class, 2 second class, 182 third class, 22 fourth class, and 22 fifth class.

4. The changes in the observatories during the year were the following :—

The first class observatory at Dodabetta was closed on the 5th September 1915 and the third class observatories at Thayetmyo and Pharijong were closed on the 1st June 1915 and 13th August 1915 respectively. The third class observatory at Table Island was closed temporarily on the 1st January 1916. The second class observatory at Mukteswar was reduced to third class on the 1st October 1915, and the fouth class observatory at Seistan was raised to third class for a period of 12 months from 1st January 1916.

First Class Observatories.

5. The Directors of the Observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded for the information of Government. It has accordingly been ruled as unnecessary to include information relating to the working of these observatories in this Administration Report.

6. *Alipore Observatory.*—This observatory is under the charge of the Meterologist, Calcutta. The following special instruments were in use during the year :—

Bergholz and Kew barographs, a Dines' microbarograph, Kew and Richard thermographs, a Beckley anemograph, a Dines' pressure tube anemometer, Beckley, Hellman-Fuess and monthly rain-gauges, an Omori-Ewing seismograph, grass and ground thermometers, and anephoscope.

All instruments issued by the Meteorological Department are tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 991 as compared with 804 last year: 51 instruments were condemned as unfit for issue, or were sent to the India Office for repair and 22 instruments were kept in store for future treatment. In addition to the above, 249 instruments were examined and issued to other observatories.

The observatory gives mean Calcutta time to the port and shipping. Three time balls are dropped daily at 1 P.M., local mean time throughout the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore Docks. This work was carried out quite satisfactorily as far as this department is concerned. There were 17 failures, as compared with 15·3, the average number of the past 27 years; but in all cases they were due to defects in the electric or mechanical arrangements outside the observatory, for which this department is not responsible.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1915-16	17	17
1914-15	24	24
1913-14	36	36
1912-13	50	50
1911-12	21	21

7. *Lahore Observatory.*—The following special instruments were in use during the year :—

Draper and Richard barographs, a Casella rain-gauge, a Beckley anemograph, a sunshine recorder, grass and ground thermometers, and a nephoscope.

Eye observations of the ordinary meteorological instruments were taken seven times daily at this observatory as in past years at 6, 8, 10, 14, 16, 18, and 22 hours. Ground surface temperature was recorded four times daily at 6, 10, 16, and 22 hours. Cloud observations were taken daily by nephoscope at 8, 12, and 16 hours for use at the Aerological Observatory, Agra.

CHARACTER OF THE WORK OF OBSERVATION AT SECOND AND THIRD CLASS OBSERVATORIES.

8. The general character of the work of the observatories, as judged by the number of mistakes made by observers, was satisfactory.

The number of stations of great reliability, in which either no mistake or only one mistake has been detected in the data for the Indian Daily Weather Report, was 27 as against 21 in 1914-15; while, the number of stations at which more than 50 mistakes were made was 4 as against 5 last year.

The usual list showing the number of mistakes in observation and in the preparation of telegrams for all the observatories which send weather telegrams to the Simla office was prepared and circulated to the observatories on the 3rd July 1916.

INSPECTION OF OBSERVATORIES.

9. The number of visits paid to observatories during the year under review was 39 as compared with 76 in the previous year and an average of 60 during the past 10 years. The number was cut down for purposes of economy.

The Director-General inspected the observatories at Calcutta, Bombay, Alibag, Agra and Allahabad. Mr. Normand inspected 2; Mr. Bion 8; Mr. P. K. Ghose 17; Mr. M. G. Subrahmanyam 5, and Mr. Budha Mall 2.

Of the 34 third class observatories that were visited 24 were reported as good, 10 as tolerable, and none as bad.

Condition.	SECOND OR THIRD CLASS OBSERVATORIES INSTECTED IN					
	1915-16.	1914-15.	1913-14.	1912-13.	1911-12.	1910-11.
Good or satisfactory	24	52	34	31	20	23
Tolerable	10	14	23	17	16	31
Bad	..	3	6	3	1	3
Total ..	34	69	63	51	37	57

In estimating the general character of the observatories from the above table it must be remembered that it is, as a rule, on account of something unsatisfactory that a visit of inspection is made. The general level of the stations is thus decidedly better than might otherwise appear. The most frequent cause of bad work is the changing of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments.

SPECIAL OBSERVATIONS.

10. Observations other than those recorded at regular intervals are made as follows:—

(*a*) In accordance with orders issued from the Simla or Calcutta office, when weather is disturbed and storm warnings may have to be issued: such observations are reported by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Re. 1 for each set of special observations sent under instructions from either Simla or Calcutta. The total number of telegrams forwarded during the year under review was 1,448 compared with 1,449 despatched the previous year.

(*b*) Certain observers, when they consider that conditions at sea are sufficiently threatening, send of their own initiative to Simla or Calcutta a telegram containing special observations. Only one such telegram was received.

(*c*) In connection with flood warning a number of observers have been instructed to send telegrams announcing the occurrence of heavy rainfall to Government officers and certain railway engineers who desire early information. The number of telegrams so sent was 191 as compared with 207 last year.

(*d*) Observers are instructed to send detailed information of earthquakes to the Simla Meteorological Office and to the Director, Geological Survey, Calcutta; for this work they are paid awards from this department. Of such reports 75 were received during the year.

Observations with special Meteorological Instruments.

11. The following special observations were carried out during the past year at certain selected stations:—

1st—Wind observations recorded by Beckley anemographs at 8 stations, and by Dines' pressure tube anemometers at 4 stations.

2nd—Solar and terrestrial radiation observations at 1 and 9 stations, respectively.

3rd—Underground temperature observations at 2 stations.

4th—Sunshine observations at 6 stations.

5th—Barometric observations recorded by self-registering instruments, chiefly Richard barographs at 18 stations.

6th—Temperature observations recorded by self-registering instruments, chiefly Richard thermographs, at 8 stations.

Observations of Solar Energy in absolute units.

12. Observations were continued at Simla throughout the year, when weather conditions allowed, by means of Angstrom's electric pyrheliometer.

Upper Air Examination.

13. The work with pilot balloons observed by theodolites was continued in north India at Agra, Simla and Kojak, and for south India at Bangalore, where the work is in the hands of the Meteorological Officer of the Mysore State and has been carried out with admirable zeal and accuracy. The trajectories to standard scale of the paths of all balloons are charted for determination of normal and abnormal conditions of wind strength and direction at all heights reached, *i.e.*, up to 10 or 11 kilometers. The number of these records now available is sufficient to provide a useful basis for a preliminary estimate of normal conditions for the various seasons of the year: the figures have accordingly been put into convenient form, and their analysis is nearly completed for publication.

In addition, pilot balloons were used for a short period at Nagpur; and balloons carrying instruments were sent up at Poona during the monsoon of 1915 and at Agra from June 1915 onwards continuously. A large proportion of these were found and returned, and those with good records afford information as to the temperature gradients and humidities at all heights reached.

The examination of past cloud records at representative stations in India for the period 1875 to 1914 has been completed for publication, and further observations at selected stations continue.

Researches by the Simla Staff.

14. Owing to the transfer of the laboratory and mechanics from Simla to Agra the opportunities for experimental research in Simla have become very greatly reduced and no experimental work is at present being undertaken in Simla. A small amount of work of a statistical nature, however, has been possible during the year, and progress has been made with the problem of forecasting the local distribution of monsoon rainfall. By combining those areas which are sufficiently homogeneous an area 'India, main' has been obtained for the monsoon rainfall of which the correlation coefficient with factors available at the beginning of June is ·7 instead of ·6, the previous coefficient for the whole of India: and as this 'India, main' contains the United Provinces, the Punjab, the North-West Frontier Province, Sind, Rajputana, Bombay, Central India, the Central Provinces, Hyderabad, Mysore, the north Madras coast and Orissa it is sufficiently large to be of considerable practical value.

Seismograph Observations.

15. Seismological observations were recorded throughout the year by two Omori-Ewing seismographs at Simla and Calcutta and one at Bombay; by Milne

seismographs at Kodaikanal and Colaba (Bombay); and by means of other self-registering instruments at the last named station. All the instruments worked satisfactorily throughout the year, and copies of certain records were transmitted to the Seismological Committee of the British Association.

Marine Meteorology.

16. No change was made during the year under review in the method of collecting marine information.

At Calcutta and Bombay a clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard, for the purpose of applying the necessary corrections to the readings in the logs; and, after the barometer comparisons have been made a statement of the error of the ship's barometer is given to the captain, in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port, but it is ample for the purposes of the department.

The data thus obtained are utilised in the preparation of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department, and in drawing up an account of the storms of the year for publication in the Annual Summary.

The arrangement made with Royal Alfred Observatory at Mauritius, for collecting marine data from the Indian Ocean, has been continued and the thanks of this department are again due to that office for thus supplying a large amount of useful data. No such data were received from the London Meterological Office during the year.

Observations recorded during the year at the entrance of the River Hughli were supplied to the Meteorological Department by the light-vessel "Star."

Snowfall Registration in the Mountain Districts to the North and West of India.

17. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete, and the thanks of the department are again due to the various officers who have collected and forwarded it. Additions to the information received have been obtained by continuing the series of large-scale photographs of the snows, as seen from Simla, which was started in 1905.

Rainfall Registration.

18. The registration of rainfall in India has invariably been carried out by the provincial authorities. In 1889 a uniform system was introduced by the Government of India, and the Director-General of Observatories was made consulting officer in connection with this work. His advice is sought regarding the starting of new rain-gauge stations, and he receives annual reports from the local officers responsible for the registration of rainfall upon the efficiency of the work. A general account of the system, which came into operation in the year 1891-92, will be found on pages 5—8 of the Administration Report of the year 1889-90, and on pages 6 and 7 of the Administration Report for the year 1890-91.

The following is a statement of the number of rain-gauge stations from which data were being received for publication in the Rainfall Data of India at the end of the year under review :—

Province or Division.	Number of rain-gauges supplying returns for publication on 31st march 1916.	Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1916.
Burma	212	Baluchistan	90
Assam	125	Rajputana	185
Bengal	227	Bombay and Sind	289
Bihar and Orissa	296	Central India	117
United Provinces	276	Central Provinces	181
Punjab	189	Hyderabad	19
Kashmir	37	Mysore	77
North-West Frontier Province ..	35	Madras (including Pudukkottai, Coorg, Travancore and Cochin).	527

The following paragraphs give a brief summary of the reports of the officers in charge of rainfall registration for the year 1915-16 :—

Assam.—The total number of rainfall stations was 125 against 124 in the preceding year. The number of gauges inspected was 86, or 6 less than in the previous year, the total number of inspections being 143 against 167 the previous year. Inspections of 45 rain-gauges were made more than once.

Baluchistan.—There were at the close of the year 91 rain-gauges : of these 44 were maintained by the railway department at railway stations, while 38 (excluding those attached to departmental observatories) were under the civil and irrigation departments. Twenty rain-gauges were inspected : the result of these inspections was generally satisfactory and the gauges were found to be in good order.

Bihar and Orissa.—The total number of rain stations including those in the Orissa Feudatory States and Tributary Mahals was 296 against 294 last year. Inspections of 163 rain-gauges were made and 164 inspection cards were received, against 155 and 99 respectively last year. The rain-gauges were mostly in good condition, and the work of registration was generally done satisfactorily.

Bengal.—There were 227 rainfall stations in the Province or three more than last year. Of these 64 stations were inspected, as against 32 in the previous year.

Bombay and Sind.—There were 278 rain-gauges in British districts as in the previous year and of these 216 were inspected as compared with 207 last year. The total number of inspections amounted to 347 against 324 last year and 101 gauges were inspected more than once. There was some falling off in the work in Native States, in that 36 gauges (out of 61) were inspected as compared with 46 inspected the previous year, seven gauges being inspected more than once.

Burma.—There were 212 rain recording stations as against 211 the previous year : of these 18 were meteorological observatories, 25 in charge of the Public Works Department, and 2 under the Agricultural Department. Inspections of 146 rain-gauges were made, an increase of 6 as compared with last year. Of these 95 were reported in good, 44 in a fair, and 7 in a bad state.

Central Provinces.—The number of rain-gauges maintained during the year was 118, as in the previous year. The number of inspections of which reports were received was 179 against 130 in the preceding year. The registration continued to be efficiently carried out.

Hyderabad.—The rainfall registering stations of Hyderabad are in charge of the Nizam's Public Works Department. There are 17 such stations as against 16 last year, all of which have been inspected and found in good condition. In addition, there is a rain-gauge at the Residency Hospital in charge of the Residency Surgeon, and one at Bolaram in charge of the Senior Medical Officer.

Kashmir.—There were 37 rain-gauges in this State, of which 8 are meteorological observatories and the remainder are in charge of the Revenue Department. Only seven gauges were inspected as compared with two inspections made last year.

Madras.—There were 499 rain recording stations at the close of the year under review, of which 397 were in the Madras Presidency : in the preceding year the corresponding figures were 477 and 394. The number of stations inspected was 391 as against 388 inspected the previous year.

Mysore.—At the close of the calendar year 1915 the number of rain recording stations was 225, the same as in the previous year. Out of these, 203 or 90 per cent. were inspected as against 86 per cent. during the previous year.

North-West Frontier Province.—The report on rainfall registration contained in the current administration report of land revenue, land records and agriculture of this province refers to the year 1914-15 and states that there were no changes in the situation or number of the rain gauges, except the rain-gauge at Tank, which was removed to a better site in the compound of the Tank Tahsil. The rain-gauge at Lakki was also found to be unreliable and will be moved. The rain-gauge sanctioned in 1913 for Tarnab has not yet been set up. The rainfall registers are properly kept up and are complete.

Punjab.—The number of rain-gauges in the Punjab during the calendar year 1915 was 244 or 13 more than last year. Of these, 149 were in charge of district officers and 95 under canal officers. There were 42 inspections during the year as against 55 last year. In addition numerous inspections were made by the Director of Land Records and his Personal Assistants. The rain-gauges under both district and canal officers are reported to be in good order and the records well kept up.

United Provinces.—There were 288 rain reporting stations in these provinces including the meteorological observatories. Out of 274 stations under the supervision of district and canal officers, 62 per cent. were inspected during the year.

Summary.—In the Central Provinces, Hyderabad, Madras, and Mysore over 75 per cent. of the rainfall stations were inspected ; in Assam, Bihar and Orissa, Bombay, Burma, and the United Provinces over 50 per cent. ; Bengal 28 per cent. ; Baluchistan 22 per cent. ; Kashmir 19 per cent ; and the Punjab 17 per cent.

The Symons' rain-gauge is being introduced throughout the Punjab Irrigation Department and will thus be universally adopted throughout British India.

The System for Storm Warning.

19. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed from the Simla Office by the Director-General of Observatories, and from the Calcutta office by the Meteorologist, Calcutta.

The following ports are warned from Simla for storms in the Arabian Sea :—

Aden, Karachi, Cutch Mandvi, Jamnagar, Dwarka, Porbandar, Veraval, Jafarabad, Bhavanagar, Daman, Bombay, Alibagh, Murud Janjira, Harnai, Ratnagiri, Malvan, Vengurla, Nova Goa, Marmagao, Karwar, Kumta, Honavar, Mangalore, Tellicherry, Calicut, Cochin, Alleppy and Colombo.

The Meteorologist, Calcutta, warns the following ports for storms in the Bay of Bengal :—

Colombo, Tuticorin, Pamban, Negapatam, Porto Novo, Cuddalore, Madras, Masulipatam, Cocanada, Vizagapatam, Calingapatam, Gopalpur, Puri, Hukitala (False Point), Chandbali, Balasore, Sandheads, Saugor Island, Diamond Harbour, Mud Point, Budge Budge, Calcutta, Morelganj, Barisal, Goalundo, Narayanganj, Noakhali, Chittagong, Cox's Bazar, Akyab, Kyaukpyu, Diamond Island, Bassein, Rangoon, Elephant Point, Moulmein, Tavoy, Mergui, Table Island (closed from 1st January 1916) and Port Blair.

The following River Police stations in Eastern Bengal and Sunderbans are also warned :—

Mudna, Nikli, Bhairab, Jaikalipur, Daudkandi, Chandpur, Pirojpur, Mirzaganj and Niamati.

20. In addition to special messages sent during stormy weather the Meteorologist, Calcutta, used to provide shipping during a large part of the year with daily information regarding the weather over the Bay. This information was made available by means of daily weather telegrams to an officer at the Port or by the hoisting of flag signals. But with the introduction of the new storm signal code on 1st January 1916, the 8 word telegrams and flag signal messages were discontinued and the following ports received daily telegrams from this office under the " General system with additional signals."

(1) Elephant Point.
(2) Diamond Island.
(3) Akyab.
(4) Chittagong.
(5) Negapatam.
(6) Cocanada.
(7) Madras.
(8) Cuddalore.
(9) Porto Novo.
(10) Bassein.
(11) Rangoon.
(12) Saugor Island.
(13) Sandheads.

Note.—At the Sandheads signals are not exhibited but information is available for passing vessels.

21. In accordance with resolutions passed at the International Radio-Telegraph Conference held in London in June and July 1912, the Indian radio-telegraph coast stations are now supplied with telegrams containing meteorological information with regard to the Arabian Sea and the Bay of Bengal. The messages are sent to the radio stations at Bombay, Karachi, Calcutta, Rangoon, Madras, and Port Blair for broadcast transmission by wireless to the shipping in the Arabian Sea and the Bay of Bengal.

Arrangements made for the receipt by wireless telegraphy of meteorological observations from ships at sea worked satisfactorily up to August 1914, when owing to the outbreak of the war these wireless telegrams had to be discontinued. A few telegrams, however, were received in 1915-16.

Warnings for Storms in the Bay of Bengal.

22. During the year warnings were issued for sixteen disturbances. Three of these developed into storms of some severity and were of sufficient importance for a statement to be given here of their course and of the action taken.

(1) On the morning of the 24th August there was a tendency towards the formation of a depression off the north Madras coast, and a well marked depression was shown there next morning. After travelling slowly northwards on the 26th and 27th, during which time it was increasing in depth, it lay near False Point on the morning of the 28th, and crossed the coast between False Point and Balasore during the next twenty-four hours.

The ports which were likely to be affected, or from which ships might run into the storm, were informed daily from the 25th of the progress of the storm and the appropriate signals were hoisted. The action taken with regard to Hukitala (False Point) is shown by the following telegrams :—

Hukitala (False Point).

26th August 1915 at 11 hrs. 8 mins. "Hoist warning* signal. Storm centre roughly latitude eighteen longitude eighty-six moving between north-west and north."

26th August 1915 at 11 hrs. 41 mins. "Storm signal hoisted at Saugor."

27th August 1915 at 10 hrs. 52 mins. "Lower warning signal. Hoist danger signal number three† storm slight intensity. Centre now near Gopalpur at present appears moving towards Puri."

28th August 1915 at 11 hrs. 34 mins. "Storm at present slight now near False Point moving northwards."

29th August 1915 at 5 hrs. 46 mins. "Lower storm signal. Storm has passed inland. Storm signal lowered at Saugor."

(2) A storm formed on the 27th September over the Andamans and on the morning of the 28th it was lying near Table Island. It then travelled in a west-north-westerly direction across the Bay and after approaching the Madras coast near Waltair on the 1st October took an abnormal course to the south-west, and slowly skirted the coast line decreasing at the same time in intensity. It finally passed inland between Cocanada and Masulipatam on the 2nd October.

Information was given daily to the ports concerned from the 28th, and the action taken with regard to Vizagapatam and Cocanada is shown by the following telegrams :—

Vizagapatam.

30th September 1915 at 10 hrs. 12 mins. "Hoist warning* signal. Storm about two hundred fifty miles east of Waltair moving some direction between north and west."

1st October 1915 at 5 hrs. 18 mins. "Lower warning signal. Hoist danger signal number three.† Storm possibly severe approaching coast between Waltair and Calingapatam."

1st October 1915 at 10 hrs. 10 mins. "Storm now close to coast between Waltair and Calingapatam winds may be very strong during the day."

1st October 1915 at 22 hrs. 56 mins. "Lower storm signal. Storm has crossed coast moving south-west inland. Its centre now near Cocanada."

2nd October 1915 at 11 hrs. 35 mins. "Depression inland near Masulipatam giving strong easterly winds from Cocanada to Puri."

Cocanada.

1st October 1915 at 5 hrs. 20 mins. "Hoist danger signal number two.‡ Storm possibly severe approaching coast between Waltair and Calingapatam."

---

* Indicating that a cyclonic storm has formed, which will probably advance to that part of the coast on which the port is situated, but is still at a considerable distance from it.

† Indicating that a cyclonic storm (probably of slight to moderate intensity) is affecting the port, and that its centre will probably cross the coast over or near to the port.

‡ Indicating that a cyclonic storm (probably of slight to moderate intensity) is affecting the port, and that its centre will probably cross the coast considerably to the north of the port.

1st October 1915 at 22 hrs. 56 mins. "Lower storm signal. Storm has crossed coast moving south-west inland. Its centre now near Cocanada."

2nd October 1915 at 11 hrs. 35 mins. "Depression inland near Masulipatam giving strong easterly winds from Cocanada to Puri."

(3) Weather was disturbed in the neighbourhood of the Andamans at the beginning of December and a storm formed in this area on the 2nd. Its centre was situated to the west of Port Blair on the morning of the 3rd and it then travelled northwards; but on reaching the neighbourhood of Table Island on the 4th it took an unusual course to the east and disappeared over the north of the Andaman Sea, probably on the night of the 5th.

Information was sent daily from the 1st to the Andamans and the Pegu coast ports, and at various times as occasion demanded warnings were sent to other ports in Burma and also to the south Madras ports when at one time the storm appeared to be moving westwards. The action taken with regard to Rangoon is shown by the following telegrams:—

RANGOON.

1st December 1915 at 10 hrs. 56 mins. "Storm probably forming west or south-west of Port Blair."

2nd December 1915 at 11 hrs. 44 mins. "Disturbance possibly severe about latitude eleven, longitude eighty-six or further east now moving towards south Madras coast."

3rd December 1915 at 10 hrs. 48 mins. "Storm about three or four hundred miles west Port Blair intensifying and at present stationary."

4th December 1915 at 10 hrs. 56 mins. "Hoist great danger signal number two.* Severe storm west Table Island moving some northerly direction."

4th December 1915 at 16 hrs. 42 mins. "Storm near Table Island is possibly moving into Andaman Sea and if so may pass near Rangoon. Shall wire again at twenty-two hours if necessary."

4th December 1915 at 21 hrs. 48 mins. "Hoist great danger signal number three.† Storm now in Andaman Sea. Will probably cross coast between Diamond Island and Moulmein to-night or early to-morrow. Suggest immediate precautions port."

5th December 1915 at 10 hrs. 38 mins. "Storm north-east Table Island moving slowly towards Rangoon or Moulmein possibly now less severe but do not relax precautions. Shall wire again about sixteen hours."

5th December 1915 at 15 hrs. 25 mins. "Storm in north Andaman Sea moving very slowly and probably diminishing in intensity. Shall wire again at twenty-two hours."

5th December 1915 at 21 hrs. 22 mins. "Storm diminished in intensity but not crossed coast. Will wire again about six hours. Better not relax precautions yet."

6th December 1915 at 6 hrs. 8 mins. "Observations at two hours shew storm not yet inland but probably much reduced intensity. Will wire again at ten hours."

6th December 1915 at 10 hrs. "Lower storm signal. Storm almost disappeared. Is likely to cross coast if it continues to exist between Moulmein and Mergui."

Perhaps in the case of the second storm the signals at Vizagapatam and Cocanada were lowered rather too early, but there is no question that the warnings have been effective on all occasions through the year.

WARNING FOR STORMS IN THE ARABIAN SEA DURING THE YEAR.

23. The Simla office warns the west coast ports, not only for storms, but also for squally weather, especially at the beginning of the monsoon. There were nineteen periods of disturbed weather in the Arabian Sea, for which warnings were issued, but none of these disturbances developed into a storm. In addition to the warnings issued to ports, telegrams giving information regarding weather were sent to the Director of Indian Marine, Bombay, in connection with the despatch of steamers to the Persian Gulf.

---

* Indicating that a cyclonic storm of great intensity is affecting the port, and that its centre will probably cross the coast considerably to the north of the port.

† Indicating that a cyclonic storm of great intensity is affecting the port, and that its centre will probably cross the coast over or near to the port.

Flood Warnings and Weather Forecasts to District, Irrigation, Railway and other Officers.

24. This work is carried out chiefly by the Simla Meteorological Office, and partly by that of Calcutta. The arrangements have been made at various times and differ considerably in character, according to the nature and extent of the flood or weather warnings required by the officers concerned. In most cases these officers require telegrams either warning them of advancing storms likely to give heavy rain, or informing them of the actual occurrence of heavy rainfall likely to give rise to severe floods which might injure railways or canal works; and in other cases they require warnings or forecasts of the weather for as long a period beforehand as possible.

The number of district officers and officers in the irrigation, telegraph, railway and other departments requiring warnings from Simla amounted at the end of the year to 201, an increase of 55 during the year.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Karachi, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

25. The number of warning messages sent from Simla during the year 1915-16 was 2,838 as compared with 2,060 in 1914-15 and 1,840 in 1913-14.

The number of warnings for heavy rainfall sent from Calcutta during the year 1915-16 was 909 as compared with 1,003 in 1914-15.

26. Instructions were issued by the Government of India in 1898 that every officer to whom storm or flood warnings are issued, should in the month of January of each year or, in the case of military expeditions, at the close of the campaign, forward to the head of this department a brief return of the warnings received and should also report—

(1) whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department,

(2) whether the warnings were timely and satisfactory in every respect and, if not, in what points they were defective,

(3) whether any changes might be made in the system which would make the warnings more useful.

Reports on the ordinary storm and flood warnings for the calendar year 1915 were received from 41 officers. Of these 30 stated that the warnings were satisfactory, 5 offered no remarks, and 4 reported that they had received no warnings during the year, while one stated that the warnings supplied usually arrived after the bad weather had begun and another that they were too vague. Enquiries indicate that in the present state of meteorological science the complaint of the last officer cannot be met.

A comparison of the reports of floods and of heavy rain with information supplied to the various officers would appear to show that the system is working satisfactorily, and that most of the warnings issued were in time and of use to the recipients.

Seasonal Forecasts.

27. The forecast for the monsoon period of 1915 dated the 7th June, was sent to Local Governments and Administrations, communicated to the press, and printed in the Gazette. A statement of the rainfall of June and July with a forecast for August and September was drawn up on the 6th August 1915 and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was drawn up on the 19th January 1916, and sent to Local Governments and Administrations.

The following are summaries of these two forecasts, and a comparison of them with the actual rainfall—

Forecast dated 7th June 1915.	Remarks.
(*a*) While the monsoon of 1915 may not be so good as that of 1914 there are no indications of a serious deficiency in the total rainfall.	The deficiency in the total rainfall was three inches, and the effect was serious in parts of north-west India.
(*b*) The Arabian Sea current is likely to be less active than the Bay current.	The Bay current was roughly normal and the Arabian Sea current was in marked weakness.

Forecast dated 6th August 1915.	Remarks.
(*a*) Although there may be one or more breaks in the monsoon, the total rainfall for August and September is more likely to be above the average than below.	The period of August and September was less below the average than that of June and July.
(*b*) There appears no reason to doubt that north-west India will share in the improvement.	There was a marked improvement in the United Provinces, the Punjab East and North, and the North-West Frontier Province.

A deficiency is usually serious in some parts of India when its average over India is about three inches, and the June forecast regarding the total amount of monsoon rainfall was somewhat too optimistic.

The August forecast also was too optimistic regarding the total amount of rainfall.

In relation to the geographical distribution of rainfall the second paragraphs of both forecasts were correct.

28. A forecast of the probable character of the rains during January and February 1916 was prepared on the 3rd January 1916 and issued in the same manner as the forecast of the previous June. On the 28th June 1916 a comparison of the actual precipitation with the above forecast was issued.

The summary of the forecast issued was :—

> "It is probable that the total amount of rainfall in north-west India and of snowfall on the neighbouring hills will be distinctly less than usual."

The total rainfall was very decidedly less than usual, and the defect was shown in all the divisions. The snowfall of the period was in some areas approximately normal and in others less than usual.

The forecast proved correct.

Daily Telegraphic Weather Summary.

29. The summary was despatched daily at about noon. It was exhibited at certain telegraph offices and sent to 89 officers of Government. The subscribers, for longer or shorter periods, were 9 newspapers and 63 private individuals.*

* Last year the corresponding figures were shown as 18 newspapers and 41 private individuals; these should have been 10 newspapers and 34 private individuals.

To officers in Simla sheets containing the summary are distributed by hand, and in May 1915 a chart showing the rainfall of the day was introduced on the back of these sheets.

Publications.

30. There were no changes made during the year in the routine publications of the department of which a description will be found in the departmental Administration Reports of 1907-08 and 1910-11.

The following memoirs of the Indian Meteorological Department were published during the year 1915-16.

"A discussion of the anemographic observations recorded at Jubbulpore, Belgaum, Deesa and Karachi"; by W. A. Harwood, M. Sc., Assistant Director, Aerological Observatory, Agra, with an introduction by Gilbert T. Walker, C.S.I., M.A., Sc. D., F.R.S., Director General of Obervatories. (Memoirs of the Indian Meteorological Department, Volume XIX, Parts V to VIII.)

"Correlation in seasonal variations of weather, IV; sunspots and rainfall"; by Gilbert T. Walker, C.S.I., M.A., Sc. D., F.R.S., Director General of Observatories. (Memoirs of the Indian Meteorological Department, Volume XXI, Part X.)

"Correlation in seasonal variations of weather, V; sunspots and temperature"; by Gilbert T. Walker, C.S.I., M.A., Sc. D., F.R.S., Director General of Observatories. Memoirs of the Indian Meteorological Department, Volume XXI, Part XI.)

"Correlation in seasonal variations of weather, VI; sunspots and pressure"; by Gilbert T. Walker, C.S.I., M.A., Sc.D., F.R.S., Director General of Observatories. (Memoirs of the Indian Meteorological Department, Volume XXI, Part XII.)

"On the Calcutta standard barometer"; by E. P. Harrison, Ph.D., F.R.S.E., (Memoirs of the Indian Meteorological Department, Volume XXI, Part XIII.)

Supply of Meteorological information.

31. In addition to the meteorological information published by the department special information was supplied to the Meteorological Departments of England, Australia and Egypt.

Climatological information, at times involving special calculation, is also provided for sanitary and other officers of Government, as well as for private firms who are willing to pay the expense necessarily incurred. The extent to which the department is utilised in this manner is increasing steadily, as will be seen from the chart appended.

Miscellaneous.

32. Six hundred and fifty-five books and pamphlets, either purchased or presented by scientific bodies were added to the library during the year, as against eight hundred and seventy-seven in the year 1913-14. The reduction is attributable to the war.

Fourteen libraries, observatories or societies were added during the year to the list of institutions to which the publications of the Indian Meteorological Department are supplied, and two were removed; the number on the list is now 359.

Chief features of the year.

33. The most important departmental events of the year have undoubtedly been those caused by the war. Dr. Harrison, who is expected to take up the important task of warning the Bay of Bengal for storms as Meteorologist, Calcutta, early next year and had come to Simla to study the system, joined the Indian Army Reserve of Officers in July 1915; and on the return of the head of the department from leave in November all the gazetted meteorological staff placed their services at the disposal of Government. After selection Messrs. Harwood and Normand were appointed to the Indian Army Reserve of Officers from the 10th and 29th February 1916, respectively; and later when a meteorological officer was asked for to give technical assistance in Mesopotamia, Dr. Simpson was deputed for the purpose from the 23rd March.

Special forecasts were made at Simla daily over several periods in connection with various military operations.

The scheme of upper air work has been very greatly hampered by the difficulty of obtaining materials at this time, but Mr. Field has succeeded in keeping up a supply of hydrogen not merely for his own balloons, but for those employed by Dr. Simpson and Mr. Harwood when on military duty. It was not expected that conclusions of importance would result from the first year of work of the scheme, but it would appear likely that the dates of the marked seasonal changes in the wind velocity at heights above seven miles may be used as an index of the earliness or lateness of the larger features of the Indian seasons.

Important events have occurred in connection with the system of warning for storms in the Bay of Bengal and Arabian Sea. Brief wireless messages giving information regarding weather in these regions were sent out broadcast to all ships within range, beginning in September 1915 ; and on the 1st January last the new system of storm signals was brought into force. The main improvements effected in this are that (*a*) it is uniform over the Indian Seas and makes a special code for Calcutta and the Hooghly ports unnecessary, (*b*) it provides separate warnings distinguishing the cases in which a port itself is threatened from those in which ships may run into danger after leaving the port, and (*c*) by simple locality signals exhibited at important places in the Bay it conveys information as to which of six areas into which the Bay has been divided are affected by bad weather, and so renders unnecessary the old special systems of flag signals and of eight-word telegrams.

One of the old landmarks of Indian meteorology has disappeared during the year. The United Provinces had half a century ago a weather officer of their own with the title of Meteorological Reporter to the Government of the United Provinces. When the department was unified in 1875, and the local officers were paid and controlled by the Government of India the titles were left unchanged, but in 1906 the new situation was more correctly expressed by new titles, the officer at Allahabad being called ' Meteorologist, Allahabad.' His duties consisted in superintending the collection and publication of provincial rainfall returns, supervising the local first class observatory, and writing meteorological reports for the Local Government. In every other province in India, however, with one exception, the rainfall work is conducted by the local government, while the first class observatory at Allahabad had been reduced to third class, and the Simla office prepares meteorological reports for other local governments. Thus a change was indicated and as a temporary experimental measure Mr. Field undertook to supervise the rainfall work at Allahabad from his observatory at Agra. But the geographical difficulties proved very great, and in February 1916 the friendly co-operation of the Local Government was sought for a solution. A scheme was then drawn up which involved the abolition of certain weekly returns that were not really required by anybody, and the transfer of the rainfall work to the Director of Land Records and Agriculture ; it has since been sanctioned, and tends to efficiency in that the Local Government now control the rainfall work of its own officers, while the more technical meteorological work is carried on by the headquarters staff of the department.

Concluding Remarks.

34. The Meteorological Department owes a large part of its usefulness to the sympathetic assistance it receives from outside departments. Civil Surgeons and other officers of Government departments, as unpaid superintendents of observatories and in other capacities, help in the meteorological work ; the Telegraph and Postal Departments assist in every way in the rapid transmission of meteorological information, at the same time that they allow their employees to act as observers. The Indo-European Telegraph Department, also, by giving free transit to the daily records of the Persian observatories, places a large amount of most useful information at the disposal of the Meteorological Department.

Weekly telegrams were received from the 1st May to the 2nd October from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams gave valuable information of the weather conditions in the Indian Ocean and the Department is indebted to the officers indicated for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal

Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the Indian Meteorological Department.

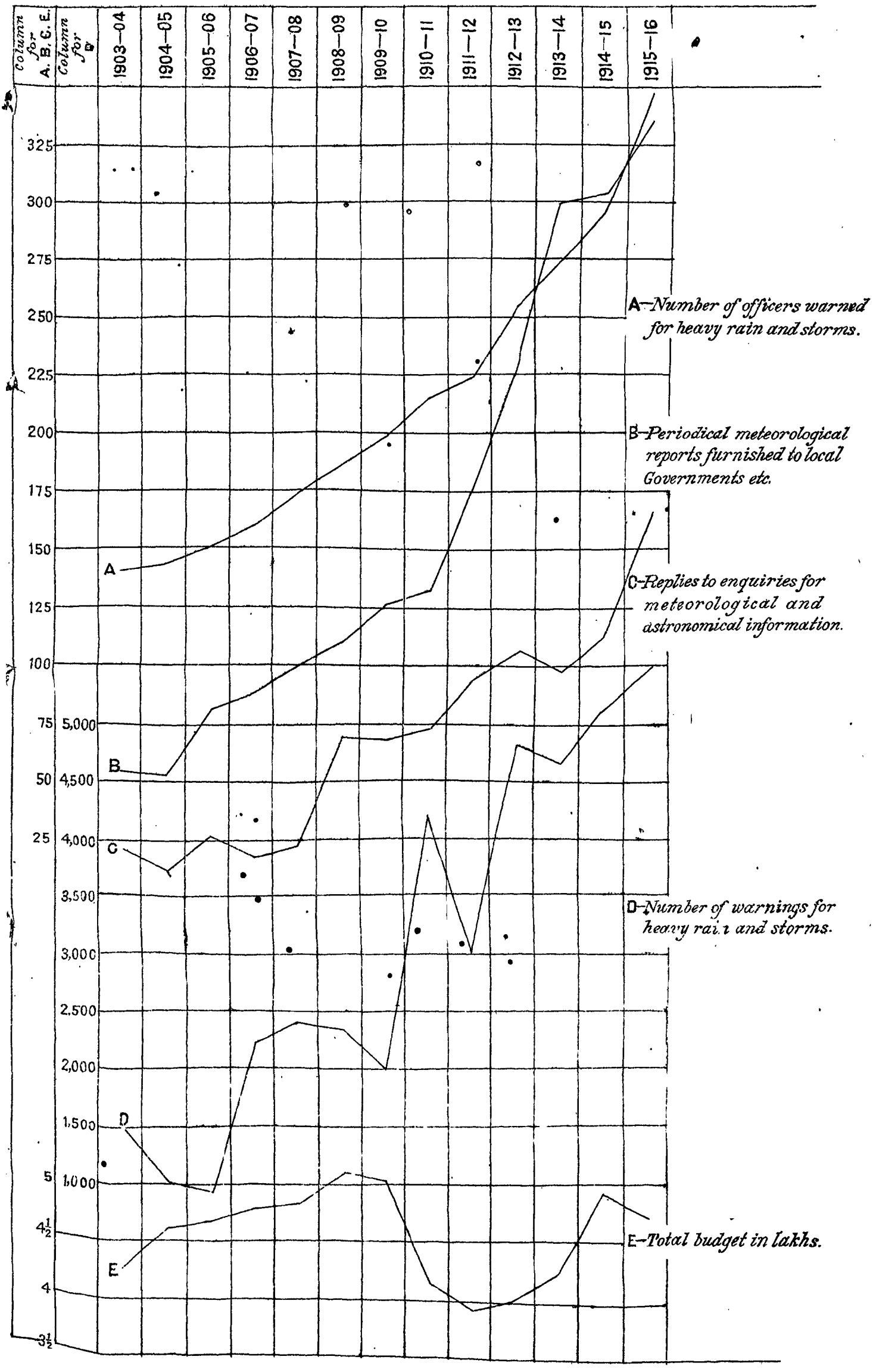
The Department is greatly indebted for important information as to meteorological conditions prevailing antecedent to and during the south-west monsoon, to the Director, Agriculture and Forestry Department, Zomba, British Central Africa; His Majesty's Commissioner, Entebbe, Uganda; the Director, Physical Service, Survey Department, Cairo; the Commonwealth Meteorologist, Melbourne; the Directors of the Observatories at Buenos Ayres and Santiago; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

SIMLA;
The 12th September 1916.

GILBERT T. WALKER,
Director General of Observatories.

G. M. Press, Simla.—No. 1DGofO.—28-9-16—200—M.D.

DIAGRAM SHOWING GROWTH IN DEPARTMENTAL ACTIVITY AND CHANGES IN TOTAL COST



REPORT ON THE ADMINISTRATION OF THE METEOROLOGICAL DEPARTMENT OF THE GOVERNMENT OF INDIA IN 1916-17.

CHANGES IN THE STAFF DURING THE YEAR 1916-17.

Dr. G. C. Simpson returned from his deputation in Mesopotamia and took over charge of his departmental duties on the 26th May 1916. Mr. W. A. Bion acted during Dr. Simpson's absence.

Mr. C. W. B. Normand was appointed to the Indian Army Reserve of Officers from the 29th February 1916 and was sent by the Army Department on the 18th June 1916 to Mesopotamia to work there as Meteorologist. He is still on this duty.

Rai Badadur Hem Raj was on privilege leave from the 22nd January 1917 to the 3rd March 1917. Mr. W. A. Bion acted.

Mr. W. A. Harwood, who was appointed to the Indian Army Reserve of Officers from the 10th February 1916, is still away on military duty.

Mr. D. B. Meek, Professor at the Dacca College, was placed on special duty in the Simla Meteorological Office for four months from the 1st July 1916 to the 31st October 1916 in order to work at the meteorological problems of north-east India and the Bay of Bengal.

Mr. T. Royds was on privilege leave from the 4th December 1916 to the 8th January 1917. Mr. S. Sitarama Aiyar acted.

Mr. R. Ll. Jones, Meteorologist, Madras, and Deputy Director of the Madras Observatory, was on privilege leave from the 22nd May 1916 to the 26th June 1916. Mr. James Angus, Professor at the Madras Christian Colllege, acted.

OBSERVATORIES.

2. The observatories maintained by the Government of India are classified as follows :-

First Class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, and wind direction and velocity, in addition to instruments read by eye.

Second Class.—Observatories at which readings are taken daily at 8 hrs., 10 hrs., and 16 hrs. : those at 8 hrs. are (with a few exceptions) transmitted by telegram to one or more of the offices at Simla, Calcutta, Bombay, and Madras for inclusion in India or Provincial Daily Weather Reports.

Third Class.—Observatories—

(*a*) where readings are taken daily at 8 hrs. only ; at those stations where there are telegraph offices the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports ;

(*b*) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only ; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determinaton of monthly and daily means which should be comparable with the means already obtained for second class observatories.

Fourth Class.—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only are recorded.

Fifth Class.-Observatories which telegraph rainfall only.

3. At the end of the year the total number of observatories was 275, of which 41 were non-departmental and 234 were maintained by the Government of India. Of the 234 departmental observatories, 5 were first class, 2 second class, 181 third class, 23 fourth class, and 23 fifth class.

4. The changes in the observatories during the year were the following:—

The third class observatory at Gyantse was closed from 1st June 1916. The third class observatory at Kerman was closed temporarily from 1st December 1916 owing to the war. The third class observatory at Table Island was reopened from 15th August 1916. The third class observatory at Seistan was temporarily extended up to the 31st March 1919. A fourth class observatory at Koraput was opened on 10th March 1917. A fifth class observatory at Dharampore was opened on 2nd December 1916.

First Class Observatories.

5. The Directors of the Observatories of Kodaikanal, Madras, and Bombay publish separate annual reports which are forwarded for the information of Government. It has accordingly been ruled as unnecessary to include information relating to the working of these observatories in this Administration Report.

6. *Alipore Observatory.*—This observatory is under the charge of the Meteorologist, Calcutta. The following special instruments were in use during the year:—

Bergholz and Kew barographs, a Dines' microbarograph, Kew and Richard thermographs, a Beckley anemograph, a Dines' pressure tube anemometer, Beckley, Hellman-Fuess and monthly rain-gauges, two Omori-Ewing seismographs, grass and ground thermometers, and a nephoscope.

All instruments issued by the Meteorological Department are tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 1,311 as compared with 991 last year: 33 instruments were condemned as unfit for issue, or were sent to the India Office for repair and 9 instruments were kept in store for future treatment. In addition to the above, 187 instruments were examined and issued to other observatories.

The observatory gives mean Calcutta time to the port and shipping. Three time-balls are dropped daily at 1 P.M., local mean time throughout the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore Docks. This work was carried out quite satisfactorily as far as this department is concerned. There were 56 failures, as compared with 16·7, the average number of the past 28 years; but out of these 41 were due to defects in the electric or mechanical arrangements outside the observatory, three due to repair to the Fort William time-ball apparatus and the remaining twelve due to breakdown of wires on account of the cyclone.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1916-17	56	41
1915-16	17	17
1914-15	24	24
1913-14	36	36
1912-13	50	50
1911-12	21	21

7 *Lahore Observatory.*—The following special instruments were in use during the year:—

Draper and Richard barographs, a Casella rain-gauge, a Beckley anemograph, a sunshine recorder, grass and ground thermometers, and a nephoscope.

Eye observations of the ordinary meteorological instruments were taken seven times daily at this observatory as in past years at 6, 8, 10, 14, 16, 18 and 22 hours. Ground surface temperature was recorded four times daily at 6, 10, 16 and 22 hours. Cloud observations were taken daily by nephoscope at 8, 12, and 16 hours for use at the Aerological Observatory, Agra.

Character of the work of Observation at second and third class observatories.

8. The general character of the work of the observatories, as judged by the number of mistakes made by observers, was satisfactory.

The number of stations of great reliability, in which either no mistake or only one mistake has been detected in the data for the Indian Daily Weather Report, was 21 as against 27 in 1915-16; while the number of stations at which more than 50 mistakes were made was 8 as against 4 last year.

The usual list showing the number of mistakes in observation and in the preparation of telegrams for all the observatories which send weather telegrams to the Simla office was prepared and circulated to the observatories on the 8th June 1917.

Inspection of Observatories.

9. The number of visits paid to observatories during the year under review was 52 as compared with 39 in the previous year and an average of 53 during the past 10 years.

The Director-General inspected the observatories at Calcutta, Bombay, Alibag, Agra, Bangalore, Madras, Kodaikanal, Lahore, and four others. Dr. Simpson inspected Basra; Mr. P. K. Ghose inspected 32, Mr. M. G. Subrahmanyam 2, and Mr. Budha Mall 4; Mr. Doraiswamy Iyer 1.

Of the 40 third class observatories that were visited 33 were reported as good and 7 as tolerable.

Condition.	SECOND OR THIRD CLASS OBSERVATORIES INSPECTED IN—					
	1916-17.	1915-16.	1914-15.	1913-14.	1912-13.	1911-12.
Good or satisfactory	33	24	52	34	31	20
Tolerable	7	10	14	23	17	16
Bad	..	..	3	6	3	1
Total ..	40	34	69	63	51	37

In estimating the general character of the observatories from the above table it must be remembered that it is, as a rule, on account of something unsatisfactory that a visit of inspection is made. The general level of the stations is thus decidedly better than might otherwise appear. The most frequent cause of bad work is the changing of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments.

Special observations.

10. Observations other than those recorded at regular intervals are made as follows:—

(*a*) In accordance with orders issued from the Simla or Calcutta Office, when weather is disturbed and storm warnings may have to be issued: such observations are reported by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Re. 1 for each set of special observations sent under instructions from either Simla or Calcutta. The total number of telegrams forwarded during the year under review was 1,582 compared with 1,448 despatched the previous year.

(*b*) Certain observers, when they consider that conditions at sea are sufficiently threatening, send of their own initiative to Simla or Calcutta a telegram containing special observations. Only one such telegram was received.

(*c*) In connection with flood warning a number of observers have been instructed to send telegrams announcing the occurrence of heavy rainfall to Government officers and certain railway engineers who desire early information. The number of telegrams so sent was 220 as compared with 191 last year.

(*d*) Observers are instructed to send detailed information of eathquakes to the Simla Meteorological Office and to the Director, Geological Survey, Calcutta; for this work they are paid awards from this department. Of such reports 60 were received during the year.

Observations with special Meteorological Instruments.

11. The following special observations were carried out during the past year at certain selected stations :—

1st.—Wind observations recorded by Beckley anemographs at 8 stations, and by Dines' pressure tube anemometers at 4 stations.

2nd—Solar and terrestrial radiation observations at 1 and 9 stations, respectively.

3rd—Underground temperature observations at 2 stations.

4th—Sunshine observations at 6 stations.

5th—Barometric observations recorded by self-registering instruments, chiefly Richard barographs, at 18 stations.

6th—Temperature observations recorded by self-registering instruments, chiefly Richard thermographs, at 8 stations.

Observations of Solar Energy in absolute units.

12. Observations at Simla by means of Angstrom's electric pyrheliometer was stopped owing to shortness of staff.

Upper Air Examination.

13. Work with pilot balloons was continued throughout 1916-17 at the same stations as previously, namely Agra, Simla, Kojak, and Bangalore. The results were treated as before, and for the series of years now available at each place most of the figures of half monthly and monthly vector resultants have been plotted to show the resultant trajectories of the period. The variations of corresponding periods from year to year are thus recognizable, for association with the variations in weather.

The series of balloons carrying recording instruments was continued at Agra.

Publication of observations and results is deferred in accordance with the general policy of Government in war time.

A year's series of air temperature observations under the normal Indian thatched thermometer shed and with two other methods of exposure, namely under a tiled shed and in a Stevenson screen, was completed. The object was to ascertain what differences in results, if any, would be involved by the adoption of the less inflammable shed for general use in India, and to estimate the divergence of temperature between the standard Stevenson screen exposure of thermometers at fourth class stations in India and that in the standard thatched shed of other Indian stations. Examination of the results shows appreciable divergences, and has raised questions which need further observations to answer. A second year's observations have therefore been started with certain modifications and additions. These include the use of a third shed, tiled and lined with wood, and the use of a motor-ventilated open-air exposure of maximum and minimum thermometers, shielded from external radiation in Assmann jacket tubes.

Researches by the Simla Staff.

14. Owing to the absence on war work of Simla gazetted officers the only researches found possible have been statistical examinations of various methods of forecasting the geographical distribution of rainfall during the second half of the monsoon period. Useful results have been obtained.

Seismograph Observations.

15. Seismological observations were recorded throughout the year by two Omori-Ewing seismographs at Simla and Calcutta & one at Bombay; by Milne seismographs at Kodaikanal and Colaba (Bombay); and by means of other self-registering instruments at the last-named station. All the instruments worked satisfactorily throughout the year, and copies of certain records were transmitted to the Seismological Committee of the British Association.

Marine Meteorology.

16. No change was made during the year under review in the method of collecting marine information.

At Calcutta and Bombay a clerk at each port spends his whole [illegible] visiting ships, making in each case a copy of the log and a comparison of the ship's barom[illegible] with a secondary standard,

for the purpose of applying the necessary corrections to the readings in the logs ; and, after the barometer comparisons have been made a statement of the error of the ship's barometer is given to the captain, in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port, but it is ample for the purposes of the department.

The data thus obtained are utilised in the preparation of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department, and in drawing up an account of the storms of the year for publication in the Annual Summary.

The arrangement made with Royal Alfred Observatory at Mauritius, for collecting marine data from the Indian Ocean, has been continued and the thanks of this department are again due to that office for thus supplying a large amount of useful data. No such data were received from the London Meteorological Office during the year.

Observations recorded during the year at the entrance of the River Hughli were supplied to the Meteorological Department by the light-vessel " Star."

Snowfall Registration in the mountain districts to the north and west of India.

17. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete, and the thanks of the department are again due to the various officers who have collected and forwarded it. Unfortunately the series of large-scale photographs of the snows, as seen from Simla, which was started in 1905, has had to be discontinued during the war.

Rainfall Registration.

18. The registration of rainfall in India has invariably been carried out by the provincial authorities. In 1889 a uniform system was introduced by the Government of India, and the Director-General of Observatories was made consulting officer in connection with this work. His advice is sought regarding the starting of new rain-gauge stations, and he receives annual reports from the local officers responsible for the registration of rainfall upon the efficiency of the work. A general account of the system, which came into operation in the year 1891-92, will be found on pages 5—8 of the Administration Report of the year 1889-90, and on pages 6 and 7 of the Administration Report for the year 1890-91.

The following is a statement of the number of rain-gauge stations from which data were being received for publication in the Rainfall Data of India at the end of the year under review :—

Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1917.	Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1917.
Burma	213	Baluchistan	91
Assam	126	Rajputana	186
Bengal	230	Bombay and Sind	289
Bihar and Orissa	297	Central India	121
United Provinces	277	Central Provinces	183
Punjab	189	Hyderabad	19
Kashmir	39	Mysore	77
North-West Frontier Province ..	36	Madras (including Pudukkottai, Coorg, Travancore and Cochin).	525

The following paragraphs give a brief summary of the reports of the officers in charge of rainfall registration for the year 1916-17 :—

Assam.—At the close of the year there were 126 rainfall stations against 125 in the preceding year. The number of gauges inspected was 90 or 4 more than in the previous year, and the

total number of inspections was 144 against 143 the previous year. Forty-two rain-gauges were inspected more than once.

Baluchistan.—There were 81 stations at the close of the year, one having been abolished. Only 14 stations were inspected against 20 the previous year.

Bihar and Orissa.—There were 298 stations including those in the Feudatory States and Tributary Mahals against 296 last year; 175 stations were inspected and 205 inspection cards were received against 164 last year. On the whole the rainfall registration work was satisfactory.

Bengal.—There were 230 rain-recording stations in the Province with three new stations in the Chittagong Hill Tracts. Of these 56 stations were inspected as against 64 inspected in the previous year.

Bombay and Sind.—The number of rain-gauges in British districts was 278, the same as last year: of these, 208 were inspected as against 216 the previous year, 86 being inspected more than once; last year 101 were inspected more than once. The total number of inspections was 312 against 347 the previous year. In Native States, 36 gauges were inspected out of 61, the same as last year: the total number of inspections was 40 against 45 the previous year.

Burma.—There were 212 rain stations, the same as last year. Of this number 18 were meteorological observatories, 25 were in charge of the Public Works Department, 2 in charge of the Agricultural Department and the rest were under District Officers. Of the rain-gauges, 157 were inspected against 146 inspected last year: 114 were in good order, 36 were in fair condition, and 7 were unsatisfactory.

Central Provinces.—The number of rain-gauges maintained during the year was 118 as in the previous year: of these 11 are meteorological observatories, 11 are mananged by the Medical Department, 16 by Feudatory States, and 60 by schoolmasters and others. There were 154 inspections against 179 the previous year. The results attained during the year were satisfactory.

Hyderabad.—The rainfall registering stations of Hyderabad are in charge of the Nizam's Public Works Department. There are 17 stations as in the previous year, all of which were inspected and found in good condition. In addition there is a rain-gauge in charge of the Residency Surgeon and one at Bolaram in charge of the Senior Medical Officer.

Kashmir.—There were 38 rain-gauges in this State, of which 8 are meteorological observatories and the remainder are in charge of the Revenue Department.

Five rain-gauges were inspected as against seven last year and steps are being taken to have all the stations inspected at least once a year.

Madras.—There were 497 rain-recording stations, of which 395 were in the Madras Presidency: in the preceding year the corresponding figures were 499 and 397. The number of stations inspected was 388 against 391 inspected the previous year.

Mysore.—At the close of the calendar year 1916, the number of rain-recording stations was 224 against 225 the previous year: of these 213 were inspected against 203 inspected last year.

North-West Frontier Province.—The report on rainfall registration contained in the current administration report of land revenue, and land records and agriculture of this province refers to the year 1915-16 and states that there was no change in the number or situation of the rain-gauges. They are reported to be in good order and the rainfall registers are properly maintained.

Punjab.—The number of rain-gauges in the Punjab was 243 as compared with 244 last year: of these, 149 are in charge of district officers and 97 in charge of irrigation officers. There were 40 inspections against 42 last year. The rain-gauges under both district and canal officers are reported to be in good order.

Rajputana and Ajmer-Merwara.—During the triennial period ending the 31st March 1916, there were 414 rain-gauges as compared with 416 during the period ending 31st March 1913. Most of the gauges were inspected during the period under review. Out of 18 rain-gauges in Kotah 13 were inspected, and none of the 14 gauges in Dholpur were inspected.

United Provinces.—There were 288 rain reporting stations in these provinces including meteorological observatories. Out of 274 stations under district and canal officers, 56 per cent. were inspected as compared with 62 per cent. inspected last year.

Summary.—In the Central Provinces, Hyderabad, Madras, Mysore, Rajputana, and Ajmer-Merwara the proportion of the rainfall stations inspected was over 75 per cent., which is satisfactory. In Assam, Bihar and Orissa, Bombay, Burma, and the United Provinces, where

between 50 and 75 per cent. of gauges were inspected, the efficiency of the system must suffer before long. But the proportons in the remaining provinces—Bengal 24 per cent, Baluchistan 17 per cent, Punjab 16 per cent., and Kashmir 13 per cent—are such as to call for serious attention.

The System for Storm Warning.

19. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed from the Simla Office by the Director-General of Observatories, and from the Calcutta Office by the Meteorologist, Calcutta.

The following ports are warned from Simla for storms in the Arabian Sea :—

Aden, Karachi, Cutch Mandvi, Jamnagar, Dwarka, Porbandar, Veraval, Jafarabad, Bhavnagar, Daman, Bombay, Alibagh, Murud Janjira, Harnai, Ratnagiri, Malvan, Vengurla, Nova Goa, Marmagao, Karwar, Kumta, Honavar, Mangalore, Tellicherry, Calicut, Cochin, Alleppy and Colombo.

The Meteorologist, Calcutta, warns the following ports for storms in the Bay of Bengal :—
Colombo, Tuticorin, Pamban, Negapatam, Porto Novo, Cuddalore, Madras, Masulipatam, Cocanada, Vizagapatam, Calingapatam, Gopalpur, Puri, Hukitala (False Point), Chandbali, Balasore, Sandheads, Saugor Island, Diamond Harbour, Mud Point, Budge Budge, Calcutta, Morelganj, Barisal, Goalundo, Narayanganj, Noakhali, Chittagong, Cox's Bazar, Akyab, Kyaukpyu, Diamond Island, Bassein, Rangoon, Elephant Point, Moulmein, Tavoy, Mergui, Table Island (reopened on 15th August 1916), and Port Blair.

The following River Police stations in Eastern Bengal and Sunderbans are also warned :—

Nikli, Bhairab, Jaikalipur, Chandanpura, Chandpur, Pirojpur, Mirzaganj, Niamati, Narayanganj, Madaripur, Gopalganj, Gournadi, Mathbhanga, Goalundo, Aralia, Sirajgang, and Madarganj.

20. In addition to special messages sent during stormy weather the Meteorologist, Calcutta, provides shipping with daily information regarding the weather over the Bay. The following ports receive daily telegrams under the "General system with additional signals :—"

(1) Table Island.
(2) Elephant Point.
(3) Diamond Island.
(4) Akyab.
(5) Chittagong.
(6) Negapatam.
(7) Cocanada.
(8) Madras.
(9) Cuddalore.
(10) Porto Novo.
(11) Bassein.
(12) Rangoon.
(13) Saugor Island.
(14) Sandheads.

Note.—Ports (1) to (11) however receive no telegrams during the period 15th January to 31st March. On the 15th January a telegram is sent to these ports saying the Ball indicating fine weather should remain suspended until further orders. At the Sandheads signals are not exhibited, but information is available for passing vessels.

21. In accordance with resolutions passed at the International Radio-Telegraph Conference held in London in June and July 1912, the Indian Radio-Telegraph coast stations are now supplied with telegrams containing meteorological information with regard to the Arabian Sea and the Bay of Bengal. The messages are sent to the radio stations at Bombay, Karachi, Calcutta, Rangoon, Madras, and Port Blair for broadcast transmission by wireless to the shipping in the Arabian Sea and the Bay of Bengal.

Arrangements made for the receipt by wireless telegraphy of meteorological observations from ships at sea worked satisfactorily up to August 1914, when owing to the outbreak of the war these wireless telegrams had to be discontinued.

Warnings for Storms in the Bay of Bengal.

22. During the year warnings were issued for eighteen disturbances. Two of these developed into severe storms and were of sufficient importance for a statement to be given here of their course and of the action taken.

(*a*) The Calcutta Storm of the 21st September, 1916.

An area of suspicious weather appeared in the Andaman Sea on the 17th September, and by next day a storm had developed in the north of the Bay. This advanced in a northerly direction, reaching a position a short distance to the east of the Sandheads by 8 hours of the 21st, and had meanwhile grown into a severe disturbance, blowing a whole gale at the Sandheads. The storm intensified still further during the day and advancing almost due north passed approximately over Calcutta between 20 and 21 hours, doing considerable damage to property: at this time the barometer fell as much as an inch below the normal height.

The ports which were likely to be affected or from which vessels might run into the storm were informed daily from the 17th of the progress of the storm and the appropriate signals hoisted. The action taken with regard to Calcutta is shown by the following telegrams :—

17th September at 10 hrs. 40 mins. Hoist distant cautionary.* Depression north Andaman Sea may rapidly develop into storm and move west-north-west direction.

19th September at 10 hrs. 50 mins. Lower cautionary. Hoist distant warning.† Storm unknown intensity roughly latitude seventeen or eighteen longitude ninety or ninety-one moving between west and north.

20th September at 10 hrs. 30 mins. Hoist local danger six.‡ Moderate storm roughly latitude nineteen longitude eighty-eight. Will probably cross coast between False Point and Saugor within thirty-six hours.

21st September at 4 hrs. 10 mins. Lower local danger six. Hoist local danger seven.§ Storm near Saugor probably moving northwards.

21st September at 10 hrs. 20 mins. Hoist great danger‖ signal number ten.

22nd September at 5 hrs. 30 mins. Lower storm signal. Storm has passed inland.

The views held in Calcutta regarding the warnings for this storm may be gathered from the following extracts :—

(1) From the Port Officer of Calcutta.

> " I have the honour to state that the storm which passed Calcutta on the 21st September 1916 was a severe one, but the port had ample warning and the damage to the shipping was practically *nil*. Of the launches (list attached) sunk, some were considered to have been improperly secured and in the case of the others there was probably some negligence.
>
> " The meteorological information was so accurate, that it was possible to time the passing of the centre of the storm within a few minutes of the time it actually passed and was of the greatest value."

(2) From the Secretary, Bengal Chamber of Commerce.

> " The storm-warnings issued by the Meteorological Department were in this case of distinct advantage to the port and the city. They were communicated to the public in good time before the storm actually broke, and proper precautions were consequently taken. The result was that the casualties to the shipping were confined to a few launches and boats, no large vessels being sunk or damaged. These facts testify to the usefulness and efficiency of the storm-warning signals, and the Committee are glad to have the opportunity of bringing them before your notice "....." No precise information as to the severity of the storm is available to the Committee, but they believe they are correct in saying that it was of exceptional violence. But, as I have indicated, the damage caused by it was not severe so far as the shipping is concerned; and, similarly, in the city itself no serious casualties, or extensive damage to property, appear to have occurred."

It is satisfactory to note that the new uniform system of warnings has been accepted by Calcutta as an efficient substitute for their old local system.

(*b*) The Madras Storm of the 22nd November 1916.

Weather was disturbed over the south of the Bay on the 19th November and a storm formed to the west of the Andamans during the day. It travelled in

---

*Indicating that there was a region of squally weather in which a storm might be forming.
†Indicating that a storm had formed.
‡Indicating that a storm of slight or moderate severity would probably cross the coast to the west of Saugor Island and north of False Point.
§Indicating the approach towards Saugor roads of a storm of slight or moderate intensity.
‖Indicating the approach of a storm of great intensity towards the mouth of the Hooghly and Calcutta.

a westerly direction and struck the coast near Madras on the early morning of the 23rd. It was a very severe disturbance and did much damage, carrying away part of the Madras harbour works, destroying many lives and much property in Pondicherry and the South Arcot district, and overturning two trains.

The ports which were likely to be affected or from which vessels might run into the storm were informed daily from the 20th of the progress of the storm and the appropriate signals hoisted. The action taken with regard to Madras is shown by the following telegrams :—

20th November at 11 hrs. 8 mins. Hoist distant* warning sections five three.† Storm forming or formed west of Port Blair.

21st November at 11 hrs. 2 mins. Hoist local warning‡. Storm about half way between Port Blair and south Madras coast at present moving westwards.

22nd November at 10 hrs. 55 mins. Hoist great danger§ No. 10. Storm roughly three hundred miles east of Cuddalore approaching coast between Cuddalore and Madras. May give you very rough weather within twenty-four hours.

23rd November at 5 hrs. 33 mins. Lower storm signal. Hoist ball. Storm has crossed coast near Madras.

The opinion of the officer responsible for shipping in the harbour is contained in the following extract :—

> " With reference to the cyclone of November 21st and 22nd, the centre of which passed to the southward and close to Madras, the warnings issued by the Meteorological Department were most efficient. I received all the information necessary from Calcutta, which together with my own observations enabled me to take all necessary steps for the safety of the shipping in this harbour.
>
> " At 11-48 A. M. on November 21st 1916 the Warning Signal was hoisted at the Harbour Office flagstaff and at 0-12 P.M. on November 22nd 1916 the Great Danger Signal was hoisted.
>
> " The storm was a severe one, two vessels in this harbour S. S. " Coconada " and S. S. " Clan Macmillan " parted their cables and put to sea, the others rode to their moorings without any material damage.
>
> " Serious damage was done by the sea to the outer breakwater, part of which was washed away together with the lighthouse at the end of it.
>
> " I am unable to suggest any improvements in the present storm warning methods as I consider they were quite satisfactory."

The Secretary to the Chamber of Commerce informed me the " Chamber has no suggestions to offer regarding the alteration or improvement of warnings issued by the Meteorological Department."

Warning for Storms in the Arabian Sea during the year.

23. The Simla Office warns the west coast ports, not only for storms, but also for squally weather, especially at the beginning of the monsoon. There were thirteen periods of disturbed weather in the Arabian Sea for which warnings were issued, but only two of these disturbances developed into storms of sufficient importance for a statement to be given here of their course and of the action taken.

(*c*) Storm of the 23rd to the 28th May.

A storm was formed over the centre of the Arabian sea on the 23rd May and travelled roughly in a northwesterly direction, passing into Arabia near the Kuria Muria Islands presumably on the 28th . It was encountered on the night of the 25th by the mail steamer " Caledonia " which experienced winds of force 8 to 9, furious squalls and high confused sea.

The ports which were likely to be effected or from which ships might run into the storm were informed daily from the 18th of the existence of disturbed weather and its development into a storm. The appropriate signals were hoisted. The action taken is shown by the following telegrams to Bombay :—

---

*Indicating that a storm has formed.

†Refers to particular areas in the Bay of Bengal.

‡Indicating that the port is threatened by a storm but it does not appear that the danger is as yet sufficiently great to justify extreme measure of precaution.

§Indicating that the port will experience severe weather from a storm of great intensity that is expected to cross over or near to the port.

18th May at 11 hrs. 45 mins. Temporary advance of monsoon winds occurring south Arabian Sea. Hoist signal number one distant cautionary.*

19th May at 11 hrs. 45 mins. Conditions unchanged.

20th May at 11 hrs. 54 mins. Disturbed conditions slightly more marked southeast Arabian Sea.

21st May at 12 hrs. 19 mins. Disturbed conditions have not developed but persist.

22nd May at 12 hrs. 22 mins. Disturbance has developed somewhat and storm may be forming south Arabian Sea.

NOTE.—On receipt of information from incoming vessels the Port Officer on his own initiative hoisted distant† warning signal number two on 22nd May.

23rd May at 12 hrs. 25 mins. Disturbance has moved slightly northwards otherwise no change.

23rd May at 13 hrs. 35 mins. Storm has probably formed and lies about four hundred miles southwest Bombay travelling some northerly direction.

24th May at 12 hrs. 26 mins. Evidence of storm less marked disturbance either moving westwards or disappearing.

25th May at 12 hrs. 52 mins. Coast observations show little evidence of disturbance. Probably either disappeared or west of sixty-six north of sixteen.

26th May at 12 hrs. 25 mins. Disturbance of past few days if existing is somewhere between Socotra and Muscat.

27th May at 12 hrs. 10 mins. Weather may be stormy near Socotra normal elsewhere. Lower signal.

(*d*) STORM OF THE 18TH TO 24TH OCTOBER.

A storm from the Bay of Bengal crossed into the Arabian Sea near Karwar on the morning of the 18th October. It travelled in a westerly direction until the morning of the 24th when it had reached a position about three hundred miles to the east of the Kuria Muria Islands. No information about its subsequent progress is available. Winds of force 8 to 9 were experienced by vessels in the inner storm area.

The ports likely to be affected or from which ships might run into the storm were informed daily from the 17th to the 20th. It was impossible to determine correctly the position and course of the storm from the coast observations.

24. It would appear that the work of storm warning was carried out as well as the present conditions permit. The most important criticism is that on the morning of the 17th October a storm from the Bay had passed inland, but my Calcutta office not being provided with data from inland stations was misled by an irregular wind into thinking that the storm was still out at sea. Arrangements are being made to send Calcutta the data of an inland station so as to prevent the recurrence of this error.

INFORMATION IN CONNECTION WITH THE SENDING OF VESSELS TO MESOPOTAMIA.

25. Information regarding weather in the Bay was sent by the Meteorologist, Calcutta, to the Captain Superintendent, Royal Indian Marine Dockyard, Calcutta, and the Principal Port Officer, Rangoon, in connection with the towage of vessels intended for Mesopotamia. Corresponding information regarding the Arabian Sea was sent by Simla to the Director of Indian Marine, Bombay, the Port Officer, Pamban and the Naval Intelligence Officer, Colombo.

---

*Indicating that there was a region of squally weather in which a storm might be forming.
†Indicating that a storm had formed.

Flood Warnings and Weather Forecasts to District, Irrigation, Railway and oher Officers.

26. This work is carried out chiefly by the Simla Meteorological Office, and partly by that of Calcutta. The arrangements have been made at various times and differ considerably in character, according to the nature and extent of the flood or weather warnings required by the officers concerned. In most cases these officers require telegrams either warning them of advancing storms likely to give heavy rain, or informing them of the actual occurrence of heavy rainfall likely to give rise to severe floods which might injure railways or canal works; and in other cases they require warnings or forecasts of the weather for as long a period beforehand as possible.

The number of district officers and officers in the irrigation, telegraph, railway and other departments requiring warnings from Simla amounted at the end of the year to 201, as in the previous year.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Karachi, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

The number of warning messages sent from Simla during the year 1916-17 was 4,879 as compared with 2,838 in 1915-16 and 2,060 in 1914-15. This large increase was due chiefly to a large number of warnings sent to military Grass and Dairy Farms.

The number of warnings for heavy rainfall sent from Calcutta during the year 1916-17 was 607 as compared with 909 in 1915-16.

27. Instructions were issued by the Government of India in 1898 that every officer to whom storm or flood warnings are issued, should in the month of January of each year or, in the case of military expeditions, at the close of the campaign, forward to the head of this department a brief return of the warnings received and should also report—

(1) whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department,

(2) whether the warnings were timely and satisfactory in every respect and, if not, in what points they were defective,

(3) whether any changes might be made in the system which would make the warnings more useful.

Reports on the ordinary storm and flood warnings for the calendar year 1915 were received from 47 officers. Of these 40 stated that the warnings were satisfactory and 7 offered no remarks.

A comparison of the reports of floods and of heavy rain with information supplied to the various officers would appear to show that the system is working satisfactorily, and that most of the warnings issued were of value to the recipients.

Seasonal Forecasts.

28. The forecasts for the monsoon period of 1916 dated the 7th June, was sent to Local Governments and Administrations, communicated to the press, and printed in the Gazette. A statement of the rainfall of June and July with a forecast for August and September was drawn up on the 7th August 1916 and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was drawn up on the 3rd January 1917 and sent to Local Governments and Administrations.

The following are summaries of these two forecasts and a comparison of them with the actual rainfall :—

Forecast dated the 7th June 1916.	Remarks.
(*a*) The outlook for the general monsoon rainfall of India is on the whole somewhat unfavourable, and the rainfall is likely to be in slight or moderate defect at any rate in the earlier part of the season.	The general monsoon rainfall of India was in excess by five inches or 14 per cent. After setting in earlier and more vigorously than usual the monsoon weakened considerably in July.
(*b*) As regards geographical distribution, apart from Lower Burma, Assam and Malabar, the only region where conditions appear favourable is south-east Madras. The deficiency which is anticipated in general elsewhere is likely to be most marked in north-west India.	The seasonal rainfall of south-east Madras was in excess. For June and July the total rainfall was below normal in the North-West Frontier Province, Sind, Rajputana and Gujarat, but in no other Provinces. Up to this time north-west India fared less well than other parts of the country; but the August rainfall in this region was exceptionally heavy.

Forecast dated the 7th August 1916.	Remarks.
(*a*) The outlook has improved and the total rainfall of August and September is likely to be in excess.	The total rainfall of August and September was in excess by $3\frac{3}{4}$ inches or 22 per cent.
(*b*) The indications regarding the geographical distribution are favourable for the United Provinces, Rajputana and Gujarat at the expense of north-east India.	The August and September rainfall of the United Provinces was in excess by 30 per cent., that of Rajputana by 81 per cent., and of Gujrat by 52 per cent.; so that all these divisions fared better than the mean of India, with its 22 per cent. On the other hand the rainfall of Assam was in defect by 4 per cent., that of Bengal in excess by 22 per cent. and that of Bihar and Orissa was normal. Thus north-east India fared less well than the rest of India.

When the June forecast was written the Zanzibar rain was about the worst on record, while the Mauritius pressure was the best on record. There seemed to be a special reason for discounting the latter, and so the forecast was unfavourable, at any rate for the early part of the season. But the pressure conditions developed extraordinarily favourably, and accordingly the monsoon proved to be the best since 1865 when our records begin. Thus the general forecast was distinctly wrong. The anticipations regarding the geographical distribution were however fairly correct.

The anticipations in the August memorandum were right both as regards the general outlook and the geographical distribution.

29. A forecast of the probable character of the rains during January and February 1917 was prepared on the 3rd January 1917 and issued in the same manner as the forecast of the previous June. On the 6th July 1917 a comparison of the actual precipitation with the above forecast was issued. The summary of the forecast issued was :—

> "It is probable that the total amount of rainfall in north-west India and of snowfall on the neighbouring hills will be less than usual, particularly in January: but it is not likely that the defect will be very large."

The rainfall of January was in large defect in all the divisions, while that of February was in defect in five divisions out of the eight. As far as rainfall is concerned the forecast was thus entirely correct. The information regarding actual snowfall is less complete than that of rainfall but it is clear that the total amount was decidedly below the average.

The predictions were thus verified.

Daily Telegraphic Weather Summary.

30. The summary was despatched daily at about noon. It was exhibited at certain telegraph offices and sent to 89 officers of Government. The subscribers for longer or shorter periods were 9 newspapers and 52 private individuals. To officers in Simla sheets containing the summary are distributed by hand, and in May 1915 a chart showing the rainfall of the day was introduced on the back of these sheets.

Publications.

31. There were no changes made during the year in the form of the routine publications of the department of which a description will be found in the departmental administration reports of 1907-08 and 1910-11 : but in view of the shortage of paper the publication of the Monthly Weather Review was stopped after the number for October 1916 and the publication of the Annual Summary after that for 1915. The monthly and annual supplements to the Indian Daily Weather Report have been printed as usual, and supply the general need for prompt informaion.

The following Memoirs of the Indian Meteorological Department were published during the year 1916-17.

"Correlation of Rainfall and the succeeding crops with special reference to the Punjab" by S. M. Jacob, I.C.S., (Memoirs of the Indian Meteorological Department, volume XXI, part XIV).

Supply of Meteorological Information.

32. In addition to the meteorological information published by the department special information was supplied to the Meteorological Departments of England, Australia and Egypt.

Climatological information, at times involving special calculation, is also provided for sanitary and other officers of Government, as well as for private firms who are willing to pay the expense necessarily incurred. The extent to which the department is utilised in this manner is increasing steadily, as will be seen from the chart appended.

Miscellaneous.

33. Three hundred and thirty-two books and pamphlets, either purchased or presented by scientific bodies were added to the library during the year, as against six hundred and fifty-five in the year 1915-16. The further reduction is attributable to the war.

Five libraries, observatories or societies were added during the year to the list of institutions to which the publications of the Indian Meteorological Department are supplied, and one was removed ; the number on the list is now 363.

Chief features of the year.

34. The outstanding events of the year have again been those brought about by the war. All possible economies had been made in the budget and a large proportion of our officers have rendered direct military service. Dr. Simpson, was deputed in March 1916 to Mesopotamia, with military rank, to provide meteorological advice and information ; and on his return in May 1916, Mr. C. W. B. Normand, who had previously joined the Indian Army Reserve of Officers and was carrying on military duties at Lahore, took his place. Mr. Harwood, formerly assistant in the Aerological Observatory at Agra and Dr. E. P. Harrison, formerly Meteorologist, Calcutta, continued their work as officers in the Indian Army Reserve and Dr. Royds, Assistant Director of the Kodaikanal Observatory has offered himelf for similar services. In view of Dr. Harrison's absence from Calcutta it became necessary to find a substitute for Mr. Peake in case of illness

or absence on leave. Mr. D. B. Meek, Professor of Physics at Dacca, was accordingly selected and deputed to Simla from July to October in order to familiarise himself with the work of the department.

Among the more important of minor events have been the classing of all part-time observers pay as 'remunerative,' so that it shall count for leave and pension. The headquarters office of the department at Simla, 'The Yarrows' was pronounced unsafe and a temporary building was erected on the Kennedy House site. As had been expected the new buildings were not large enough to hold the instruments, records and library as well as the staff, and three rooms were put at our disposal in Benmore in Chota Simla. The removal was effected in November and some inconvenience is experienced under the new conditions; but in a temporary arrangement planned with a view to special economy this appears inevitable.

Concluding Remarks.

35. The Meteorological Department owes a large part of its usefulness to the sympathetic assistance it receives from outside departments. Civil Surgeons and other officers of Government departments, as unpaid superintendents of observatories and in other capacities, help in the meteorological work; the Telegraph and Postal Departments assist in every way in the rapid transmission of meteorological information, at the same time that they allow their employees to act as observers. The Indo-European Telegraph Department, also, by giving free transit to the daily records of the Persian observatories, places a large amount of most useful information at the disposal of the Meteorological Department. Weekly telegrams were receivd from May to September from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams gave valuable information of the weather conditions in the Indian Ocean and the Department is indebted to the officers indicated for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the Indian Meteorological Department.

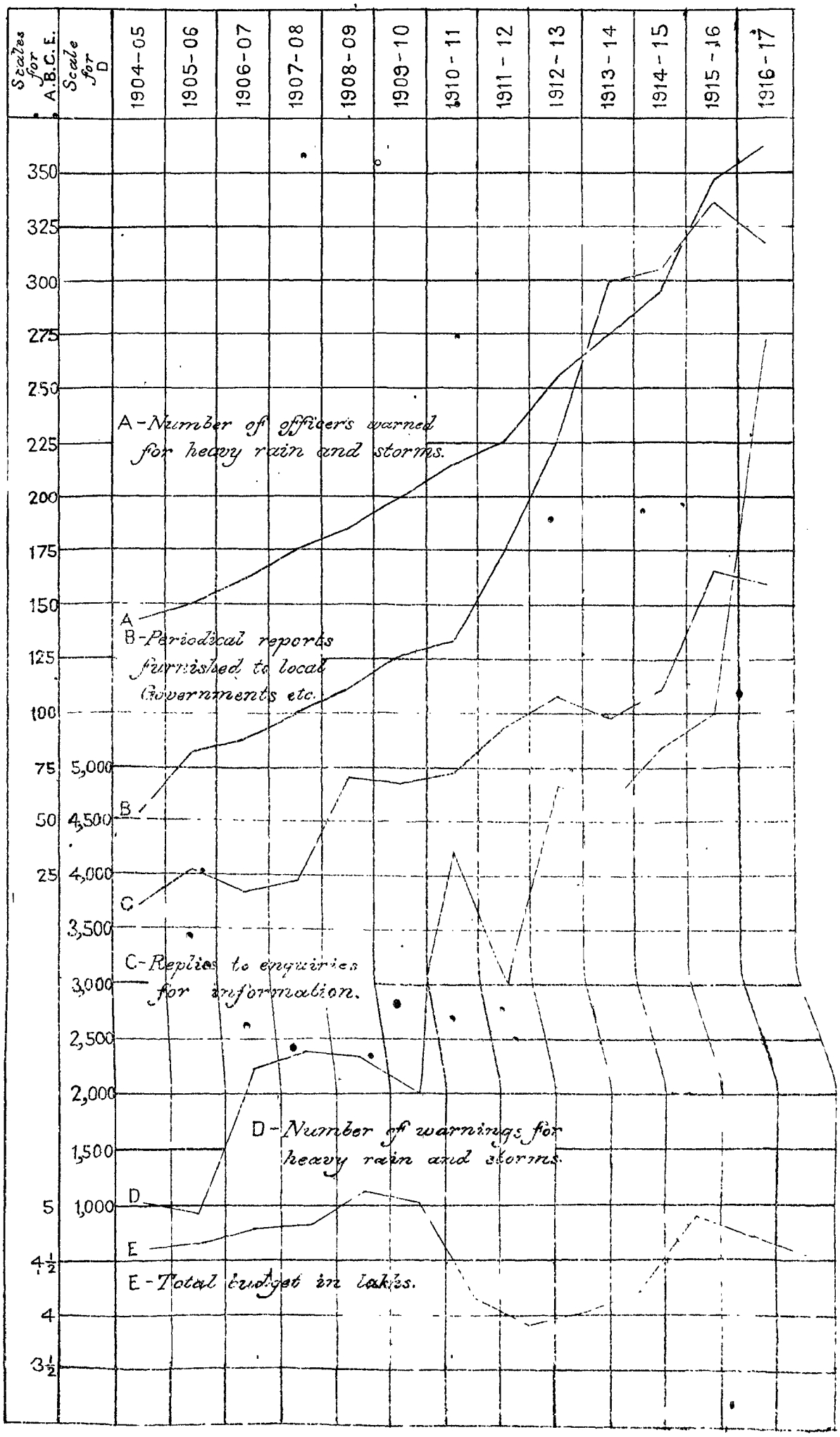
The Department is greatly indebted for important information as to meteorological conditions prevailing antecedent to and during the south-west monsoon, to the Director, Agriculture and Forestry Department, Zomba, British Central Africa; His Majesty's Commissioner, Entebbe, Uganda; the Director, Physical Service, Survey Department, Cairo; the Commonwealth Meteorologist, Melbourne; the Directors of the Observatories at Buenos Ayres and Santiago; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

Simla,
The 19th September 1917.

GILBERT T. WALKER,
Director General of Observatories.

G. M. Press, Simla.—No 1 D.G. of O.—1-10 17—290—A.H.

DIAGRAM SHOWING GROWTH IN DEPARTMENTAL ACTIVITY AND CHANGES IN TOTAL COST



REPORT ON THE ADMINISTRATION OF THE METEOROLOGICAL DEPARTMENT OF THE GOVERNMENT OF INDIA IN 1917-18.

CHANGES IN THE STAFF DURING THE YEAR 1917-18.

The services of Dr. G. C. Simpson were placed at the disposal of the Indian Munitions Board from the 25th April 1917. He is still working there and Mr. W. A. Bion is appointed as sub. *pro tempore* Imperial Meteorologist in his place.

Mr. C. W. B. Normand was appointed to the Indian Army Reserve of Officers from the 29th February 1916, and was sent by the Army Department on the 18th June 1916 to Mesopotamia to work there as Meteorologist. He is still on this duty. Mr. M. G. Subrahmanyam, Head Clerk, Bombay Meteorological Office, has been acting for him from the 1st February 1918.

Mr. W. A. Harwood, who was appointed to the Indian Army Reserve of Officers from the 10th February 1916, is still away on military duty.

Mr. C. W. Peake, Meteorologist, Calcutta, has been on combined leave since the 9th May 1917. Mr. D. B. Meek, Professor at the Presidency College, Calcutta, is acting for him.

Mr. J. Evershed was on privilege leave from the 12th December 1917 to the 11th January 1918.

The services of Dr. T. Royds were placed at the disposal of the Army Department for employment in the Office of the Director of Ordnance Factories, Calcutta, from the 24th October 1917. He is still there and Mr. S. Sitarama Aiyar is appointed as sub. *pro tempore* Assistant Director of the Kodaikanal Observatory in his place.

OBSERVATORIES.

2. The observatories maintained by the Government of India are classified as follows :—

First Class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, and wind direction and velocity, in addition to instruments read by eye.

Second Class.—Observatories at which readings are taken daily at 8 hrs., 10 hrs., and 16 hrs.; those at 8 hrs., are (with a few exceptions) transmitted by telegram to one or more of the offices at Simla, Calcutta, Bombay, and Madras for inclusion in India or Provincial Daily Weather Reports.

Third Class.—Observatories—

(*a*) where readings are taken daily at 8 hrs. only; at those stations where there are telegraph offices the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports ;

(*b*) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only ; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determination of monthly and daily means which should be comparable with the means already obtained for second class observatories.

Fourth Class.—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only are recorded.

Fifth Class.—Observatories which telegraph rainfall only.

3. At the end of the year the total number of observatories was 273, of which 41 were non-departmental and 232 were maintained by the Government of India. Of the 232 departmental observatories 5 were first class, 181 third class, 23 fourth class, and 23 fifth class.

4. The changes in the observatories during the year were the following :—

The observer's work at Pasni was so bad that the third class observatory there had to be closed from the 19th July 1917 to the 11th October 1917 until another man could be appointed. The second class observatories at Kalabagh and Sarain on the Chur Peak were closed from the 1st December 1917. The third class observatory at Baghdad was re-opened on the 4th January 1918.

First Class Observatories.

5. The Directors of the observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded for the information of Government. It has accordingly been ruled as unnecessary to include information relating to the working of these observatories in this Administration Report.

6. *Alipore Observatory.*—This observatory is under the charge of the Meteorologist, Calcutta. The following special instruments were in use during the year :—

A Bergholz barograph, a Dines' microbarograph, a Kew thermograph, a Beckley anemograph, a Dines' pressure tube anemometer, Beckley, Hellman-Fuess and monthly rain-gauges, two Omori-Ewing seismographs, grass and ground thermometers, and a nephoscope. The Kew barograph and the Richard thermograph were put out of use from the 2nd August and the 6th November 1917 respectivly.

All instruments issued by the Meteorological Department are tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 1,470 as compared with 1,311 last year : 32 instruments were condemned as unfit for issue, or were sent to the India Office for repair and 5 instruments were kept in store for future treatment. In addition to the above, 196 instruments were examined and issued to other observatories.

The observatory gives mean Calcutta time to the port and shipping. Three time-balls are dropped daily at 1 p.m., local mean time throughout the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore Docks. This work was carried out quite satisfactorily as far as this department is concerned. There were 34 failures, as compared with 17·3, the average number of the past 29 years ; all these were due to defects in the electric or mechanical arrangements outside the observatory, for which this department is not responsible.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1917-18	34	34
1916-17	56	41
1915-16	17	17
1914-15	24	24
1913-14	36	36
1912-13	50	50

7. *Lahore Observatory*—The following special instruments were in use during the year :—

A Draper barograph, a Casella rain-gauge, a Beckley anemograph, a sunshine recorder, grass and ground thermometers, and a nephoscope. The Richard barograph was put out of use from the 5th November 1917.

Eye observations of the ordinary meteorological instruments were taken seven times daily at this observatory as in past years at 6, 8, 10,14, 16, 18, and 22 hours. Ground surface temperature was recorded four times daily at 6, 8, 10, 16 and 22 hours. Cloud observations were taken daily by nephoscope at 8,12 and 16 hours for use at the Aerological Observatory, Agra.

Character of the work of Observation at second and third class observatories.

8. The general character of the work of the observatories, as judged by the number of mistakes made by observers, was satisfactory.

The number of stations of great reliability, in which either no mistake or only one mistake has been detected in the data for the Indian Daily Weather Report, was 33 as against 21 in 1916-17; while the number of stations at which more than 50 mistakes were made was 3 as against 8 last year.

The usual list showing the number of mistakes in observation and in the preparation of telegrams for all the observatories which send weather telegrams to the Simla office was prepared and circulated to the observatories on the 7th June 1918.

Inspection of Observatories.

9. The number of visits paid to observatories during the year under review was 44 as compared with 52 in the previous year and an average of 54 during the past 10 years.

The Director-General inspected the observatories at Bombay and Agra. Mr. W. A. Bion inspected 6, Mr. P. K. Ghose 27, Mr. M. G. Subrahmanyam 1, and Mr. Budha Mall 8.

Of the 42 third class observatories that were visited 27 were reported as good, 11 as tolerable and 4 as bad.

Condition.	Second or third class observatories inspected in —					
	1917-18.	1916-17.	1915-16.	1914-15.	1913-14.	1912-13.
Good or satisfactory	27	33	24	52	34	31
Tolerable	11	7	10	14	23	17
Bad	4	..	..	3	6	3
Total ..	42	40	34	69	63	51

In estimating the general character of the observatories from the above table it must be remembered that it is, as a rule, on account of something unsatisfactory that a visit of inspection is made. The general level of the stations is thus decidedly better than might otherwise appear. The most frequent cause of bad work is the changing of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments.

Special Observations.

10. Observations other than those recorded at regular intervals are made as follows:–

(*a*) In accordance with orders issued from the Simla or Calcutta Office, when weather is disturbed and storm warnings may have to be issued: such observations are reported by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Re. 1 for each set of special observations sent under instructions from either Simla or Calcutta. The total number of telegrams forwarded during the year under review was 1,878 compared with 1,532 during the previous year.

(*b*) Certain observers, when they consider that conditions at sea are sufficiently threatening, send of their own initiative to Simla or Calcutta a telegram containing special observations. Six such telegrams were received.

(*c*) In connection with flood warning a number of observers have been instructed to send telegrams announcing the occurrence of heavy rainfall to Government officers and certain railway engineers who desire early information. The number of telegrams so sent was 275 as compared with 220 last year.

(*d*) Observers are instructed to send detailed information of earthquakes to the Simla Meteorological Office and to the Director, Geological Survey, Calcutta; for this work they are paid awards from this department. Of such reports 83 were received during this year.

Observations with special Meteorological Instruments.

11. The following special observations were carried out during the past year at certain selected stations:—

1st.—Wind observations recorded by Beckley anemographs at 8 stations, and by Dines' pressure tube anemometers at 4 stations.

2nd.—Solar and terrestrial radiation observations at 1 and 8 stations, respectively.

3rd.—Underground temperature observations at 2 stations.

4th.—Sunshine observations at 6 stations.

5th.—Barometric observations recorded by self-registering instruments, chiefly Richard barographs, at 18 stations.

6th.—Temperature observations recorded by self-registering instruments, chiefly Richard thermographs, at 9 stations.

Observations of Solar Energy in absolute units.

12. Observations at Simla by means of Angstrom's electric pyrheliometer continued in abeyance owing to shortness of staff.

Upper Air Examination.

13. Work with pilot balloons was continued throughout 1917-18 at the same stations as previously, Agra, Simla, Kojak, and Bangalore; and it was started at Lahore on the 20th March, 1918. The results were treated as before, and for the series of years now available at each place most of the figures of half monthly and monthly vector resultants have been plotted to show the resultant trajectories of the period. The variations of corresponding periods from year to year are thus recognizable, for association with the variations in weather.

The series of balloons carrying recording instruments was continued at Agra.

Publication of observations and results is deferred in accordance with the general policy of Government in war time.

A year's series of air temperature observations under the normal Indian thatched thermometer shed and with two other methods of exposure, namely under a tiled shed and in a Stevenson screen, was completed. The object was to ascertain what differences in results, if any, would be involved by the adoption of the less inflammable shed for general use in India, and to estimate the divergence of temperature between the standard Stevenson screen exposure of thermometers at fourth class stations in India and that in the standard thatched shed of other Indian stations. Examination of the results shows appreciable divergences, and has raised questions which need further observations to answer. A second year's observations have therefore been started with certain modifications and additions. These include the use of a third shed, tiled and lined with wood, and the use of a motor-ventilated open-air exposure of maximum and minimum thermometers, shielded from external radiation in Assmann jacketed tubes. A number of important results are indicated but the examination of these is not yet completed.

Researches by the Simla Staff.

14. Owing to the absence on war work of Simla gazetted officers the only researchs found possible have been statistical examinations of various types. These are shortly stated in section 33 below.

Seismograph Observations.

15. Seismological observations were recorded throughout the year by two Omori-Ewing seismographs at Simla and at Calcutta and one at Bombay; by Milne seismographs at Kodaikanal and Colaba (Bombay); and by means of other self-registering instruments at the last-named station. All the instruments worked satisfactorily throughout the year, and data were transmitted to the Seismological Committee of the British Association.

Marine Meteorology.

16. No change was made during the year in the method of collecting marine information.

At Calcutta and Bombay a clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard, for the purpose of applying the necessary corrections to the readings in the logs; and, after the barometer comparisons have been made, a statement of the error of the ship's barometer is given to the captain, in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port, but it is ample for the purposes of the department.

The data thus obtained are utilised in the preparation of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department, and in drawing up an account of the storms of the year for publication in the Annual Summary.

The arrangement made with Royal Alfred Observatory at Mauritius, for collecting marine data from the Indian Ocean, has been continued, and the thanks of this department are again due to that office for thus supplying a large amount of useful data. No such data were received from the London Meteorological Office during the year.

Snowfall Registration in the mountain districts to the north and west of India.

17. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete, and the thanks of the department are again due to the various officers who have collected and forwarded it. Unfortunately the series of large-scale photographs of the snows, as seen from Simla, which was started in 1905, has had to be discontinued during the war.

Rainfall Registration.

18. The registration of rainfall in India has invariably been carried out by the provincial authorities. In 1889 a uniform system was introduced by the Government of India, and the Director-General of Observatories was made consulting officer in connection with this work. His advice is sought regarding the starting of new rain-gauge stations, and he receives annual reports from the local officers responsible for the registration of rainfall upon the efficiency of the work. A general account of the system, which came into operation in the year 1891-92, will be found on pages 5—8 of the Administration Report of the year 1889-90, and on pages 6 and 7 of the Administration Report for the year 1890-91.

The following is a statement of the number of rain-gauge stations from which data were received for publication in the Rainfall Data of India at the end of the year :—

Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1918.	Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1918.
Burma	213	Baluchistan	90
Assam	125	Rajputana	186
Bengal	230	Bombay and Sind	289
Bihar and Orissa	300	Central India	122
United Provinces	275	Central Provinces and Berar ..	189
Punjab	190	Hyderabad	19
Kashmir	39	Mysore	77
North-West Frontier Province ..	36	Madras (including Pudukkottai, Coorg, Travancore and Cochin).	525

The following paragraphs give a brief summary of the reports of the officers in charge of rainfall registration for the year 1917-18 :—

Assam.—The number of gauges inspected was 56 or 34 less than in the previous year, and the total number of inspections was 82 against 144 the previous year. Nineteen rain-gauges were inspected more than once.

Baluchistan.—Only 14 stations were inspected.

Bihar and Orissa.—Here out of 300 stations 183 stations were inspected and 219 inspection cards were received against 205 last year. On the whole the rainfall registration work was satisfactory.

Bengal.—Of the 230 rain-recording stations in the Province 40 stations were inspected as against 56 in the previous year.

Bombay and Sind.—Out of 278 rain-gauges in British districts 206 were inspected, 89 being inspected more than once. The total number of inspections was 304. In Native States, 40 gauges were inspected out of 61 : the total number of inspections was 48.

Burma.—Of 212 rain stations 18 were meteorological observatories, 25 were in charge of the Public Works Department, 2 in charge of the Agricultural Department and the rest were under District Officers. Of the rain-gauges, 152 were inspected : 117 were in good order, 29 were in fair condition, and 6 were unsatisfactory.

Central Provinces.—There were 175 inspections against 154 the previous year. The results attained during the year show that the work of registration is carried out with efficiency.

Berar.—The number of inspections of the 43 rain-gauges was 103 against 161 in the previous year.

Hyderabad.—The rainfall registering stations of Hyderabad are in charge of the Nizam's Public Works Department. There are 17 stations, of which 11 were inspected during the year. In addition there is a rain-gauge in charge of the Residency Surgeon and one at Bolaram in charge of the Senior Medical Officer.

Kashmir.—There were 38 rain-gauges in this State, of which 8 are meteorological observatories and the remainder are in charge of the Revenue Department.

Fourteen rain-gauges were inspected as against five last year.

Madras.—Out of 496 rain-recording stations 395 were in the Madras Presidency, and of these the number inspected was 390.

Mysore.—At the close of the calendar year 1917, the number of rain-recording stations was 226 against 224 the previous year : of these 201 were inspected against 213 inspected last year.

North-West Frontier Province.—The report on rainfall registration contained in the current administration report of land revenue, land records and agriculture of this province refers to the year 1916-17 and states that there was no change in the situation of the rain-gauges. These and the rainfall registers are generally reported to be in good order and properly maintained.

Punjab.—The number of rain-gauges in the Punjab was 243, of which 149, are in charge of district officers and 97 in charge of irrigation officers. There were 43 inspections of the district rain-gauges. Those under irrigation officers were regularly inspected.

Rajputana and Ajmer-Merwara.—During the triennial period ending the 31st March 1916, there were 414 rain-gauges, of which most were inspected during the period under review. Out of 18 rain-gauges in Kotah 13 were inspected, and none of the 14 gauges in Dholpur were inspected

United Provinces.—Out of 271 stations under district and canal officers, 51 per cent. were inspected as compared with 56 per cent. last year.

Summary.—In the Central Provinces, Berar, Madras, and Mysore, the proportion of the rainfall stations inspected was over 75 per cent., which is satisfactory. In Assam, Bihar and Orissa, Burma, Hyderabad and the United Provinces, where between 50 and 75 per cent. of gauges were inspected, the efficiency of the system must suffer before long. But the proportions in the remaining provinces — Bombay 46 per cent., Kashmir 37 per cent., Punjab 28 per cent., Baluchistan 18 per cent., and Bengal 17 per cent — are such as to call for serious attention.

The System for Storm Warning.

19. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed from the Simla Office by the Director-General of Observatories, and from the Calcutta Office by the Meteorologist, Calcutta.

The following ports are warned from Simla for storms in the Arabian Sea :—

Aden, Karachi, Cutch Mandvi, Jamnagar, Dwarka, Porbandar, Veraval, Jafarabad, Bhavnagar, Daman, Bombay, Alibagh, Murud Janjira, Harnai, Ratnagiri, Malvan, Vengurla, Nova Goa, Marmagao, Karwar, Kumta, Honavar, Mangalore, Tellicherry, Calicut, Cochin, Alleppy, Quilon, Trivandrum, Colachel, Busra, and Colombo.

The Meteorologist, Calcutta, warns the following ports for storms in the Bay of Bengal :—

Colombo, Tuticorin, Pamban, Negapatam, Porto Novo, Cuddalore, Madras, Masulipatam, Cocanada, Vizagapatam, Calingapatam, Gopalpur, Puri, Hukitala (False Point), Chandbali, Sandheads, Saugor Island, Diamond Harbour, Mud Point, Budge Budge, Calcutta, Khulna, Barisal, Goalundo, Narayanganj, Chandpur, Noakhali, Chittagong, Cox's Bazar, Akyab, Kyaukpyu, Diamond Island, Bassein, Rangoon, Elephant Point, Moulmein, Tavoy, Mergui, Table Island (reopened on 15th August 1916), and Port Blair.

The following River Police stations in Eastern Bengal and Sunderbans are also warned :—

Nikli, Bhairab, Chandpur, Mirzaganj, Narayanganj, Madaripur, Gopalganj, Gournadi, Goalundo, Aralia, Sirajgang, Lohajang, Sara, Godagari, Rampur Boalia and Khoksa.

20. In addition to special messages sent during stormy weather the Meteorologist, Calcutta, provides shipping with daily information regarding the weather over the Bay. The following ports receive daily telegrams under the "General system with additional signals" :—

(1) Table Island.
(2) Elephant Point.
(3) Diamond Island.
(4) Akyab.
(5) Chittagong.
(6) Negapatam.
(7) Cocanada.
(8) Madras.
(9) Cuddalore.
(10) Porto Novo.
(11) Bassein
(12) Rangoon.
(13) Saugor Island.
(14) Sandheads.

Note.—Ports (1) to (12) however receive no telegrams during the period 15th January to 31st March. On the 15th January a telegram is sent to these ports saying the Ball indicating fine weather should remain suspended until further orders. At the Sandheads signals are not exhibited, but information is available for passing vessels.

21. In accordance with resolutions passed at the International Radio-Telegraph Conference held in London in June and July 1912, the Indian Radio-Telegraph coast stations are now supplied with telegrams containing meteorological information with regard to the Arabian Sea and the Bay of Bengal. The messages are sent to the radio stations at Bombay, Karachi, Calcutta, Rangoon, Madras, and Port Blair for broadcast transmission by wireless to the shipping in the Arabian Sea and the Bay of Bengal.

Arrangements made for the receipt by wireless telegraphy of meteorological observations from ships at sea worked satisfactorily up to August 1914, when owing to the outbreak of the war these wireless telegrams had to be discontinued.

Warnings for storms in the Bay of Bengal.

22. During the year warnings were issued for nineteen disturbances. Three of these developed into storms of some severity, and regarding the two most important a detailed statement is given here of their course and of the action taken.

Storm of 30th April—3rd May 1917.

A depression began to form in the south of the Bay on the 30th April. At 8 hrs. on the 1st May it was still without any definite centre, but was lying about 300 or 400 miles to the east of Negapatam. During the next 24 hours it developed into a storm, and moved in a northerly direction to a position about 400 miles east of Nellore. It then travelled with unusual rapidity and was about 75 miles east of False Point by 8 hours of the 3rd, crossing the coast the same afternoon between Balasore and Saugor Island.

The ports which were likely to be affected or from which vessels might run into the storm were informed daily from the 1st May of the progress of the storm, so far as was ascertained from the coast observations, and signals were hoisted. The action taken with regard to Saugor Island and Balasore is shown by the following telegrams :—

Saugor Island.

1st May at 10 hrs. 45 mins. Hoist distant cautionary (*a*) section four.* Weather suspicious off south Madras coast.

2nd May at 11 hrs. 8 mins. Hoist distant warning (*b*) sections four five.* Storm position doubtful roughly four hundred miles east Negapatam. Track uncertain.

3rd May at 8 hrs. 15 mins. Hoist distant warning (*b*) sections two three.* Storm reached north Bay moving some northerly direction will wire later approximate position centre.

3rd May at 9 hrs. 17 mins. Hoist danger signal number seven (*d*).

3rd May at 20 hrs. Lower storm signal hoist ball (*f*). Storm now inland.

Balasore.

3rd May at 9 hrs. 22 mins. Hoist great danger signal (*e*). Severe storm may strike you almost at once.

3rd May at 18 hrs. Lower storm signal. Storm crossing coast near Saugor Island.

As Balasore possessed only the brief system of signals it was not necessary to hoist any signal there until the port was threatened. The actual notice given was rather short as the position of the storm was not realised until the morning of the 3rd.

Storm of 24th—30th October 1917.

A storm was forming near the Andamans on the 24th October. It developed and moved in a north-westerly direction until the morning of the 28th, when it was about 150 miles south-east of Gopalpur ; it then took a northerly course and was close to the coast off Gopalpur on the morning of the 29th. After this it travelled along the coast and was to the north of Calcutta on the evening of the 30th.

The ports which were likely to be affected or from which vessels might run into the storm were informed daily from the 25th of the progress of the storm, and signals were hoisted. The action taken with regard to Hukitala, Diamond Harbour and Calcutta is shown by the following telegrams :—

Hukitala (False Point).

25th October at 11 hrs. 22 mins. Hoist distant cautionary (*a*). Weather disturbed north-west Port Blair two hundred miles.

26th October at 10 hrs. 37 mins. Weather disturbed two hundred miles west-south-west Diamond Island.

27th October at 11 hrs. 8 mins. Weather disturbed centre Bay between Waltair and Diamond Island.

27th October at 21 hrs. 41 mins. Hoist local cautionary (*c*). Moderate storm two hundred miles off Calingapatam approaching coast.

28th October at 11 hrs. 35 mins. Moderate storm two hundred miles off coast latitude nineteen.

29th October at 11 hrs. 12 mins. Moderate storm on coast near Gopalpur. Weather squally Orissa coast and north-west angle Bay.

30th October at 13 hrs. 2 mins. Lower storm signal. Storm north-west Balasore moving north-east weather still squally north-west angle Bay.

---

*Refers to the sections of the Bay which were affected.

(*a*) Indicating that there was a region of squally weather in which a storm might be forming.

(*b*) Indicating that a storm had formed.

(*c*) Indicating that the port was threatened by squally weather.

(*d*) Indicating that the port would experience severe weather from a storm of slight or moderate intensity that was expected to cross over or near to the port.

(*e*) Indicating that the port would experience severe weather from a storm of great intensity that was expected to cross over or near to the port.

(*f*) Indicating fine weather.

Diamond Harbour.

*25th October at 11 hrs. 19 mins. Hoist distant cautionary (*a*). Weather disturbed north-west Port Blair two hundred miles.

26th October at 10 hrs. 46 mins. Weather disturbed two hundred miles west-south-west Diamond Island.

27th October at 11 hrs. 2 mins. Weather disturbed centre Bay between Waltair and Diamond Island.

*27th October at 22 hrs. 14 mins. Hoist distant warning (*b*). Moderate storm two hundred miles off Calingapatam.

28th October at 11 hrs. 32 mins. Moderate storm two hundred miles off coast latitude nineteen.

29th October at 11 hrs. 15 mins. Moderate storm on coast near Gopalpur. Weather squally Orissa coast and north-west angle Bay.

*29th October at 12 hrs. 40 mins. Hoist local cautionary (*c*).

30th October at 13 hrs. 5 mins. Storm fifty miles north-west Balasore moving north-east. Weather squally north-west angle Bay.

*30th October at 21 hrs. 10 mins. Lower storm signal. Storm slightly north-west Calcutta moving east-north-easterly giving heavy rain.

Calcutta.

The telegrams sent to Calcutta were those shown under Diamond Harbour with an asterisk.

It appears that although the position of the storm was correctly indicated to the ports affected, the signals did not very adequately convey the degree of danger. At Hukitala for instance only 'cautionary' signals, indicating squally weather, were hoisted, but not 'danger' signals to indicate the admitted existence of a 'moderate storm.' At Calcutta and Diamond Harbour the local danger signals should have been hoisted. Fortunately however although winds at sea were fairly strong those on shore were quite feeble and probably no harm was done.

STORM OF 29TH SEPTEMBER—2ND OCTOBER 1917.

This storm was of slight intensity and affected a comparatively small area. The signals hoisted gave adequate warning to the ports concerned.

WARNING FOR STORMS IN THE ARABIAN SEA DURING THE YEAR.

23. The Simla Office warns the west coast ports, not only for storms, but also for squally weather, especially at the beginning of the monsoon. There were eleven periods of disturbed weather in the Arabian Sea for which warnings were issued, but only two of these disturbances developed into storms.

The first formed during the advance of the monsoon which occurred at the Malabar coast near the end of May. Signals were hoisted at the ports telling of the likelihood of squally weather on the 25th, and were lowered on the 26th as the disturbance receded from the coast. In the meantime a severe storm had formed, probably in the west of the Arabian Sea, which was encountered by the S.S. "Portsea" on the 25th-26th May in the neighbourhood of the Kuria Maria Island. No further signals were hoisted as the storm formed too far from our west coast stations to affect their observations.

STORM OF 18TH—25TH OCTOBER 1917.

A storm of moderate severity formed off Malabar on the 18th and 19th October and travelled in a northerly direction. It struck the Kathiawar coast near Porbandar at noon on the 25th.

The ports which were likely to be affected or from which ships might run into the storm were informed daily from the 18th of the development and movement of the storm, and the appropriate signals were hoisted. As the storm was

(*a*) Indicating that there was a region of squally weather in which a storm might be forming.
(*b*) Indicating that a storm had formed.
(*c*) Indicating that the port was threatened by squally weather.

during the greater part of its existence at a considerable distance from the coast the observations at the coast stations did not give any clear indication of either its position or character. The action taken is shown by the following telegrams sent to Veraval, Porbandar and Dwarka :—

18th October at 11 hrs. 52 mins. Disturbed conditions off Malabar coast. Hoist signal number one distant cautionary (*a*).

19th October at 12 hrs. 4 mins. Conditions are still disturbed south-east Arabian Sea.

20th October at 11 hrs. 53 mins. Storm probably forming fourteen degrees north sixty-eight east.

20th October at 22 hrs. 24 mins. Indications of disturbance fainter perhaps moving west.

21st October at 11 hrs. 55 mins. Disturbance apparently unchanged.

21st October at 22 hrs. 2 mins. Disturbance apparently unchanged.

22nd October at 11 hrs. 56 mins. Disturbance still appears about sixteen north sixty-eight east.

22nd October at 21 hrs. 56 mins. Depression probably giving disturbed weather south-east Arabian Sea.

23rd October at 12 hrs. 39 mins. Replace signal number one distant cautionary (*a*) by signal number three local cautionary (*c*). Storm probably forming seventeen north sixty-eight east may give rough weather your port.

23rd October at 18 hrs. 24 mins. Storm probably formed about eighteen north sixty-seven east. Replace signal number three local cautionary (*c*) by signal number four local warning (*g*).

23rd October at 23 hrs. Observations indicate very little change in storm.

24th October at 11 hrs. 55 mins. Replace signal number four warning (*g*) by number seven danger (*d*). Storm two hundred miles off Veraval threatens your port.

24th October at 16 hrs. 46 mins. Storm hundred fifty miles south-west of Veraval moving north or north-east.

24th October at 23 hrs. 7 mins. Storm now about hundred miles south-west of Veraval moving northwards perhaps weakening will probably cross coast near Porbandar noon tomorrow Thursday.

25th October at 5 hrs. 7 mins. Storm still moving very slowly northwards.

25th October at 11 hrs. 42 mins. Storm of moderate severity now crossing inland near Dwarka.

25th October at 16 hrs. 25 mins. Storm passed inland over Porbandar about noon strong winds will persist to-day.

25th October at 22 hrs. 20 mins. Storm slowly weakening inland but still causing rough weather.

26th October at 10 hrs. 54 mins. Storm now in Rajputana lower signal.

INFORMATION IN CONNECTION WITH THE SENDING OF VESSELS TO MESOPOTAMIA.

24. Information regarding weather in the Bay was sent by the Meteorologist, Calcutta, to the Captain Superintendent, Royal Indian Marine Dockyard, Calcutta, and the Principal Port Officer, Rangoon, in connection with the towage of vessels intended for Mesopotamia. Corresponding information regarding the Arabian Sea was sent by Simla to the Director of Indian Marine, Bombay, the Port Officer, Pamban, and the Naval Intelligence Officer, Colombo.

(*a*) Indicating that there was a region of squally weather in which a storm might be forming.
(*c*) Indicating that the port was threatened by squally weather.
(*d*) Indicating that the port would experience severe weather from a storm of slight or moderate intensity that was expected to cross over or near to the port.
(*g*) Indicating that the port was threatened by a storm but that it did not yet appear that the danger was sufficiently great to justify extreme measures of precaution.

Flood Warning and Weather Forecasts to District, Irrigation, Railway and other Officers.

25. This work is carried out chiefly by the Simla Meteorological Office, and partly by that of Calcutta. The arrangements have been made at various times and differ considerably in character, according to the nature and extent of the flood or weather warnings required by the officers concerned. In most cases these officers require telegrams either warning them of advancing storms likely to give heavy rain, or informing them of the actual occurrence of heavy rainfall likely to give rise to severe floods which might injure railways or canal works ; and in other cases they require warnings or forecasts of the weather for as long a period beforehand as possible.

The number of district officers and officers in the irrigation, telegraph, railway and other departments requiring flood warnings from Simla amounted at the end of the year to 206, as compared with 201 in the previous year. There were also 5 officers of the Telegraph Department who required warnings for strong winds.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Karachi, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

The number of warning messages sent from Simla during the year 1917-18 was 5,789 as compared with 4,879 in 1916-17 and 2,838 in 1915-16. In addition to these there were 26 warnings for strong winds sent to officers of the Telegraph Department.

The number of warnings for heavy rainfall and strong winds sent from Calcutta during the year 1917-18 was 1,100 and for only strong winds 255, thus making a total of 1,355, as compared with 607 in 1916-17.

26. Instructions were issued by the Government of India in 1898 that every officer to whom storm or flood warnings are issued should in the month of January of each year or, in the case of military expeditions, at the close of the campaign, forward to the head of this department a brief return of the warnings received and should also report—

(1) whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department ;

(2) whether the warnings were timely and satisfactory in every respect and, if not, in what points they were defective ;

(3) whether any changes might be made in the system which would make the warnings more useful.

Reports on the ordinary storm and flood warnings for the calendar year 1917 were received from 43 officers. Of these 34 stated that the warnings were satisfactory, but there were frequent delays in transmission in the case of warnings sent to Orissa, probably owing to interruptions on the line. One officer stated that the warnings arrive rather late and 8 offered no remarks.

A comparison of the reports of floods and of heavy rain with information supplied to the various officers would appear to show that the system is working satisfactorily, and that most of the warnings issued were of value to the recipients. As an illustration the following note may be of interest. It formed part of the report submitted by the Executive Engineer, Rupar Division, Sirhind Canal :—

> "I may specially note that the storm telegram gave us timely warning of the approach of the abnormal and very heavy monsoon storm at the end of October, and the canal was consequently closed in good time in anticipation of nil indents, which was very beneficial for all concerned."

Seasonal Forecasts.

27. The forecast for the monsoon period of 1917, dated the 6th June, was sent to Local Governments and Administrations, communicated to the press, and printed in the Gazette. A statement of the rainfall of June and July with a forecast for

August and September was drawn up on the 7th August 1917 and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was drawn up on the 1st January 1918 and sent to Local Governments and Administrations.

The following are summaries of these two forecasts and comparison of them with the actual rainfall :—

Forecast dated the 6th June 1917.	Remarks.
(*a*) The outlook for the general monsoon rainfall of India is on the whole favourable, and the rainfall is likely to be in excess, at any rate in the earlier part of the season.	The general monsoon rainfall was in excess by slightly over seven inches, or twenty per cent. and the total for each half of the season was in excess.
(*b*) In spite of the recent cold there is no reason to expect that the rainfall of north-west India will suffer to any marked extent by comparison with that of the rest of India.	The percentage excesses of the provinces of north-west India were : United Provinces 22, Punjab 92, Kashmir 53, North-West Frontier Province 64, Sind 114, Rajputana 103, Central India West 35, and Gujarat 28. It will be seen therefore that the rainfall of north-west India was far from suffering by comparison with that of the rest of India.

Forecast dated the 7th August 1917.	Remarks.
(*a*) The total rainfall of August and September is likely to be in excess.	The rainfall of the period was in excess by 5·7 inches or 34 per cent.
(*b*) The indications regarding the geographical distribution are not sufficiently strongly developed to be reliable. They merely suggest that the United Provinces West and neighbouring districts may fare better than the rest of India in the ratio of the actual to the normal rainfall.	The percentage excesses of the districts in question were :—United Provinces West 33, United Provinces East 17, Central India West 49, Rajputana East 138, Punjab East and North 130.

Both in June and August the anticipations of a general excess of rainfall were justified.

Regarding the geographical distribution reasons were given in June for expecting that both the Arabian Sea and the Bay monsoon currents would be stronger than usual, as well as that there would be no prejudicial effect of snowfall in north-west India. These expectations were fulfilled.

In the forecast for August and September the uncertain indications that the area about the United Provinces West would get a larger percentage rainfall than the rest of India proved correct. The average of the percentage excesses of the five divisions given above is 73, while that of the whole of India was 34.

28. A forecast of the probable character of the rains during January and February 1918 was prepared on the 2nd January 1918 and issued in the same manner as the forecast of the previous June. On the 3rd July 1918 a comparison of the actual precipitation with the above forecast was issued. The summary of the forecast issued was :—

> "It is probable that the total amount of rainfall in north-west India and of snowfall on the neighbouring hills in January and February will be normal or in moderate excess."

The total amounts both of rainfall and snowfall during January and February were however decidedly less than usual and that the forecast was definitely wrong

Daily Telegraphic Weather Summary.

29. The summary was despatched daily at about noon. It was exhibited at certain telegraph offices and sent to 82 officers of Government. The subscribers for longer or shorter periods were 10 newspapers and 42 private individuals. To officers in Simla sheets containing the summary with a chart showing the rainfall of the day are distributed by hand.

Publications.

30. There were no changes made during the year in the form of the routine publications of the department of which a description will be found in the departmental administration reports of 1907-08 and 1910-11 : but in view of the shortage of paper the publication of the Monthly Weather Review had been stopped after the number for October 1916 and the publication of the Annual Summary after that for 1915. The monthly and annual supplements to the Indian Daily Weather Report have been printed as usual, and supply the general need for prompt information.

Supply of Meteorological Information.

31. In addition to the meteorological information published by the department special information was supplied to the Meteorological Departments of England, Australia and Egypt.

Climatological information, at times involving special calculation, is also provided for sanitary and other officers of Government, as well as for private firms who are willing to pay the expense necessarily incurred. The extent to which the department is utilised in this manner will be seen from the chart appended.

Miscellaneous.

32. Four hundred and eleven books and pamphlets, either purchased or presented by scientific bodies, were added to the library during the year, as against three hundred and thirty-two in the year 1916-17.

Eight libraries, observatories or societies were added during the year to the list of institutions to which the publications of the Indian Meteorological Department are supplied, and one was removed ; the number on the list is now 370.

Chief Features of the year.

33. At the beginning of the year Dr. Simpson, Imperial Meteorologist, left the Simla office to become Assistant Secretary to the Board of Munitions during the war ; and as the Simla office had already lost the services of Mr. Normand, who had been appointed meteorologist with the forces in Mesopotamia, its scientific activities were inevitably diminished.

Use was however made of the computing staff to compute, statistica methods, a number of correlation coefficients bearing on the distribution of monsoon rainfall, as well as others dealing with sanitary and economical questions.

At the Solar Physics Observatory, Kodaikanal, also the staff was materially reduced ; Dr. Royds, the Assistant Director, joined the Indian Army Reserve of Officers in October 1917 for ordnance work.

During the year the department has lost the services of Mr. C. W. Peake, Professor in Physics at the Presidency College, Calcutta. He had served as Meteorologist, Calcutta, with much zeal and efficiency since 1906.

The routine work of the department was maintained with but little change except that the publication of the Indian Monthly Weather Review and its Annual Summary was discontinued in view of printing difficulties during the war ; it was considered that the monthly and annual supplements to the Indian Daily Weather Report, which were being maintained, were sufficient for most administrative purposes. Among the weather observing stations the chief event has been the closing of those at Sarain and Kalabagh on the Chur Peak. These had been started by Sir John Eliot as upper air observatories. But general experience has shown that measurements made on mountains differ appreciably

from those in the free air ; also the inaccessibility of the Chur Peak made effective supervision extremely difficult ; hence it became clear that the results were not worth their cost.

There were during the year three storms of importance in the Bay and two in the Arabian Sea : warnings were given to the Indian ports for all except one which was too near Arabia to affect the observatories on our west coast.

Concluding Remarks.

34. The Meteorological Department owes a large part of its usefulness to the sympathetic assistance it receives from outside departments. Civil Surgeons and other officers of Government departments, as unpaid superintendents of observatories and in other capacities, help in the meteorological work ; the Telegraph and Postal Departments assist in every way in the rapid transmission of meteorological information, at the same time that they allow their employees to act as observers. The Indo-European Telegraph Department, also, by giving free transit to the daily records of the Persian observatories, places a large amount of most useful information at the disposal of the Meteorological Department. Weekly telegrams were received from May to September from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams gave valuable information of the weather conditions in the Indian Ocean and the Department is indebted to the officers indicated for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the Indian Meteorological Department.

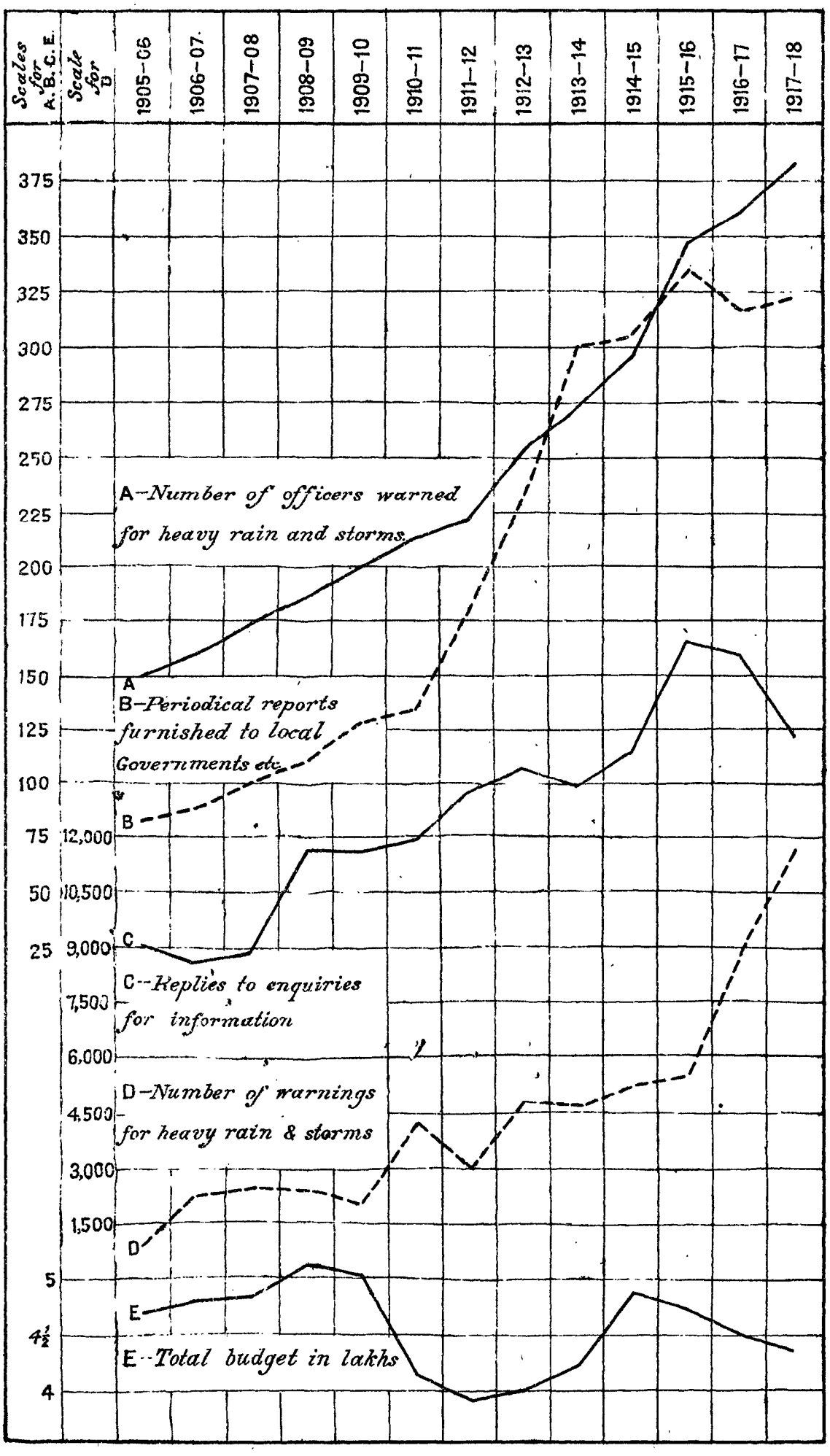
The Department is greatly indebted for important information as to meteorological conditions prevailing antecedent to and during the south-west monsoon to the Director, Physical Service, Survey Department, Cairo ; the Directors of the Observatories at Buenos Ayres and Santiago ; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

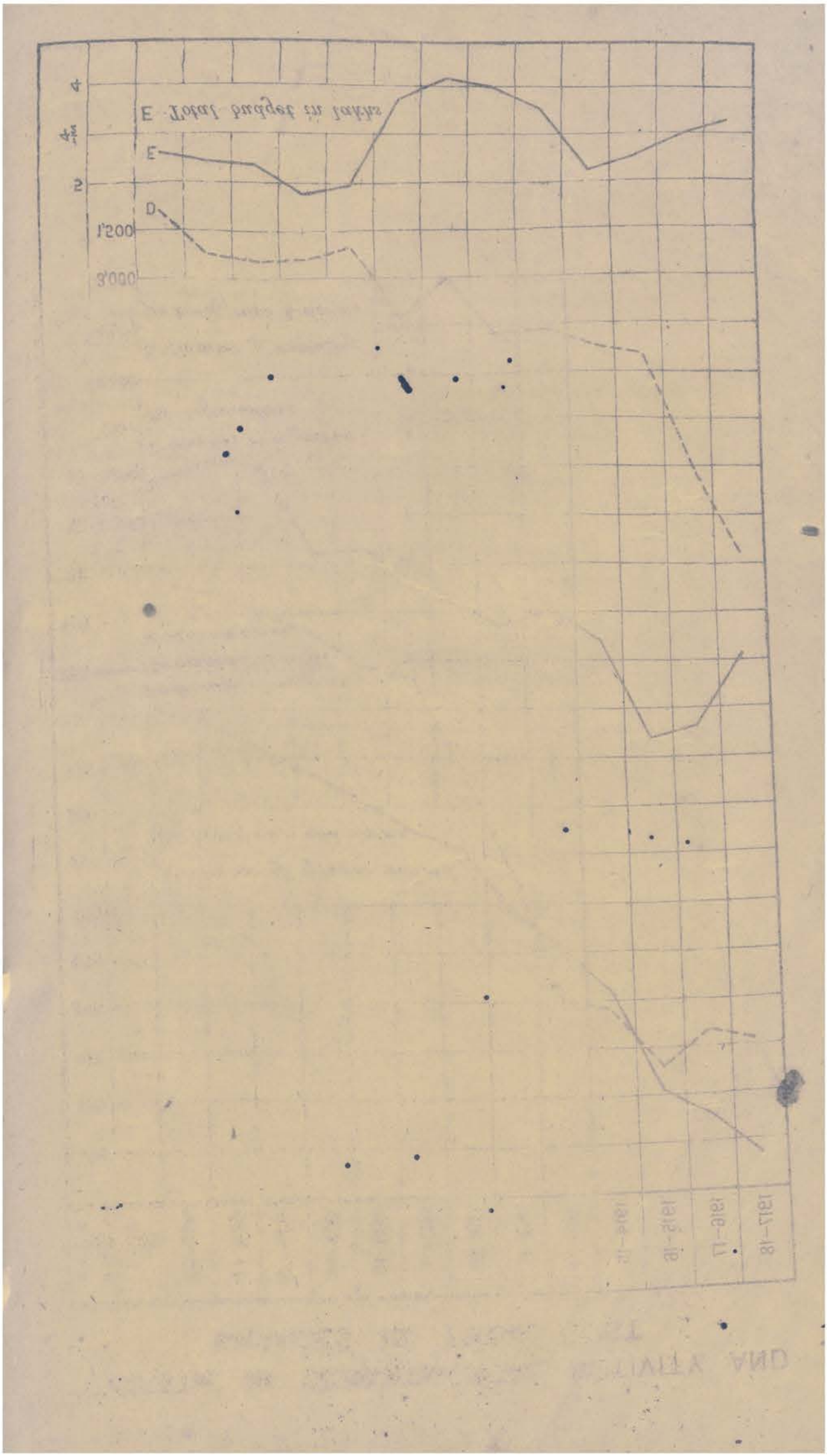
Simla :
The 27th September 1918.

GILBERT T. WALKER,
Director General of Observatories.

G. M. Press, Simla.—No. 1D.G.O.—8-10-18—290—E.A.

GROWTH IN DEPARTMENTAL ACTIVITY AND CHANGES IN TOTAL COST




E
D
1'200
2
4

REPORT ON THE ADMINISTRATION OF THE METEOROLOGICAL DEPARTMENT OF THE GOVERNMENT OF INDIA IN 1918-19.

CHANGES IN THE STAFF DURING THE YEAR 1918-19.

The services of Dr. G. C. Simpson were placed at the disposal of the Indian Munitions Board from the 25th April 1917 to the 31st March 1919.

Mr. C. W. B. Normand was appointed to the Indian Army Reserve of Officers from the 29th February 1916, and was sent by the Army Department on the 18th June 1916 to Mesopotamia to work there as Meteorologist. Mr. M. G. Subrahmanyam, Head Clerk, Bombay Meteorological Office, acted for him from the 1st February 1918 to the 30th September 1918, and was appointed sub. *pro tempore* Imperial Meteorologist from the 1st October 1918.

Mr. J. H. Field has been on combined leave since the 17th May 1918. Mr. W. A. Harwood, who was appointed to the I. A. R. O. from the 10th February 1916, rejoined the Meteorological Department on the 18th March 1919, and has been acting as Director, Aerological Observatory, Agra, from that date.

Mr. C. W. Peake, Meteorologist, Calcutta, who was on combined leave from the 9th May 1917, retired from service from the 25th October 1918. Dr. E. P. Harrison who is appointed as Meteorologist, Calcutta, is at present employed in the Army as A. C. R. E. and Mr. D. B. Meek, Professor at the Presidency College, Calcutta, is acting in his place.

Mr. R. Ll. Jones, Meteorologist, Madras and Deputy Director, Madras Observatory, was on privilege leave from the 1st May to the 16th June 1918. Mr. James Angus, Professor at the Madras Christian College, acted for him.

Mr. H. M. Ffinch was appointed Meteorologist at Bombay from the 17th May 1918, *vice* Mr. C. D. deV. Babington transferred.

The services of Dr. T. R yds were placed at the disposal of the Army Department for employment in the office of the Director of Ordnance Factories, Calcutta, from the 24th October 1917. Mr. S. Sitaramayya was appointed sub. *pro tempore* Assistant Director of the Kodaikanal Observatory.

OBSERVATORIES.

2. The observatories maintained by the Government of India are classified as follows :—

First Class.—Observatories which are furnished with autographic instruments for continuously recording pressure, temperature, humidity, and wind direction and velocity, in addition to instruments read by eye.

Second Class.—Observatories at which readings are taken daily at 8 hrs., 10 hrs., and 16 hrs. ; those at 8 hrs., are (with a few exceptions) transmitted by telegram to one or more of the offices at Simla, Calcutta, Bombay, and Madras for inclusion in India or Provincial Daily Weather Reports.

Third Class.—Observatories—

(*a*) where readings are taken daily at 8 hrs. only ; at those stations where there are telegraph offices, the observations are transmitted by telegram for inclusion in the Simla, Calcutta, Bombay or Madras Daily Weather Reports ;

(*b*) at stations where there are no telegraph offices, and observations are recorded at 10 hrs. and 16 hrs. only ; these are included in the Monthly Weather Reviews, and furnish a series of observations for the determination of monthly and daily means which should be comparable with the means already obtained for second class observatories.

Fourth Class.—Observatories at which observations of temperature, wind and rainfall only, or of temperature and rainfall only are recorded.

Fifth Class.—Observatories which telegraph rainfall only.

3. At the end of the year the total number of observatories was 274, of which 41 were non-departmental and 233 were maintained by the Government of India. Of the 233 departmental observatories, 5 were first class, 181 third class, 23 fourth class, and 24 fifth class.

4. The only change in the observatories during the year was the following :—

a fifth class observatory was opened at Car Nicobar on 1st July 1918.

First Class Observatories.

5. The Directors of the observatories of Kodaikanal, Madras and Bombay publish separate annual reports which are forwarded for the information of Government. It has accordingly been ruled as unnecessary to include information relating to the working of these observatories in this Administration Report.

6. *Alipore Observatory.*—This observatory is under the charge of the Meteorologist, Calcutta. The following special instruments were in use during the year :—

A Bergholz barograph, a Dines' microbarograph, a Kew thermograph, a Beckley anemograph, a Dines' pressure tube anemometer, Beckley, Hellman-Fuess and monthly rain-gauges, two Omori-Ewing seismographs, grass and ground thermometers, and a nephoscope.

All instruments issued by the Meteorological Department are tested at this observatory and their corrections ascertained before they are sent out for use. The number of instruments tested and verified during the year was 491 as compared with 1,470 last year : 10 instruments were condemned as unfit for issue, or were sent to the India Office for repair and 17 instruments were kept in store for future treatment. In addition to the above, 162 instruments were examined and issued to other observatories.

The observatory gives mean Calcutta time to the port and shipping. Three time-balls are dropped daily at 1 p.m., local mean time, throughout the year, one on the Semaphore Tower at Fort William, the second at the Port Commissioners' office and the third at the Kidderpore Docks. This work was carried out quite satisfactorily as far as this department is concerned. There were 50 failures, as compared with 17·9, the average number of the past 30 years ; all these were due to defects in the electric or mechanical arrangements outside the observatory, for which this department is not responsible.

Year.	Number of days on which one or other ball failed to drop properly.	Number of failures due to telegraphic defects.
1918-19	50	50
1917-18	34	34
1916-17	56	41
1915-16	17	17
1914-15	24	24
1913-14	36	36
1912-13	50	50

7. *Lahore Observatory.*—The following special instruments were in use during the year :—

A Draper barograph, a Casella rain-gauge, a Beckley anemograph, a sunshine recorder, grass and ground thermometers, and a nephoscope.

Eye observations of the ordinary meteorological instruments were taken seven times daily at this observatory as in past years at 6, 8, 10, 14, 16, 18, and 22 hours. Ground surface temperature was recorded four times daily at 6, 10, 16 and 22 hours. Cloud observations were taken daily by nephoscope at 8,12 and 16 hours for use at the Aerological Observatory, Agra.

Character of the work of Observation at second and third class observatories.

8. The general character of the work of the observatories, as judged by the number of mistakes made by observers, was satisfactory.

The number of stations of great reliability in which either no mistake or only one mistake has been detected in the data for the Indian Daily Weather Report, was 22 as against 33 in 1917-18; while the number of stations at which more than 50 mistakes were made was 6 as against 3 last year.

The usual list showing the number of mistakes in observation and in the preparation of telegrams for all the observatories which send weather telegrams to the Simla office was prepared and circulated to the observatories on the 16th September 1919.

Inspection of Observatories.

9. The number of visits paid to observatories during the year under review was 36 as compared with 44 in the previous year and an average of 51 during the past 10 years.

The Director-General inspected the observatories at Calcutta, Madras, Bombay and Agra. Rai Bahadur Hem Raj inspected 2, Mr. P. K. Ghose 26, Mr. V. Doraiswamy 1, and Mr. Budha Mall 1.

Of the 30 third class observatories that were visited, 16 were reported as good, 9 as tolerable and 5 as bad.

Condition.	Second or third class observatories inspected in —					
	1918-19.	1917-18.	1916-17.	1915-16.	1914-15.	1913-14.
Good or satisfactory	16	27	33	24	52	34
Tolerable	9	11	7	10	14	23
Bad	5	4	..	..	3	6
Total ..	30	42	40	34	69	63

In estimating the general character of the obsevatories from the above table it must be remembered that it is, as a rule, on account of something unsatisfactory that a visit of inspection is made. The general level of the stations is thus decidedly better than might otherwise appear. The most frequent cause of bad work is the changing of observers at short intervals necessitated by acting and other arrangements in the Medical, Telegraphic and Postal Departments.

Special Observations.

10. Observations other than those recorded at regular intervals are made as follows:—

(*a*) In accordance with orders issued from the Simla or Calcutta Office, when weather is disturbed and storm warnings may have to be issued: such observations are reported by telegraph. Certain observers at coast observatories are in receipt of a regular monthly allowance of Rs. 5 for sending special storm warning telegrams, while other observers receive an allowance of Re. 1 for each set of special observations sent under instructions from either Simla or Calcutta. The total number of telegrams forwarded during the year under review was 1,033 compared with 1,878 during the previous year.

(*b*) Certain observers, when they consider that conditions at sea are sufficiently threatening, send of their own initiative to Simla or Calcutta a telegram containing special observations. Three such telegrams were received.

(*c*) In connection with flood warning a number of observers have been instructed to send telegrams announcing the occurrence of heavy rainfall to Government officers and certain railway engineers who desire early information. The number of telegrams so sent was 131 as compared with 275 last year.

(*d*) Observers are instructed to send detailed information of earthquakes to the Simla Meteorological Office and to the Director, Geological Survey, Calcutta; for this work they are paid awards from this department. Of such reports, 100 were received during this year.

Observations with special Meteorological Instruments.

11. The following special observations were carried out during the past year at certain selected stations :—

1st—Wind observations recorded by Beckley anemographs at 6 stations, and by Dines' pressure tube anemometers at 4 stations.

2nd—Solar and terrestrial radiation observations at 1 and 8 stations, respectively.

3rd—Underground temperature observations at 2 stations.

4th—Sunshine observations at 6 stations.

5th—Barometric observations recorded by self-registering instruments, chiefly Richard barographs, at 12 stations.

6th—Temperature observations recorded by self-registering instruments, chiefly Richard thermographs, at 6 stations.

Observations of Solar Energy in Absolute units.

12. Observations at Simla by means of Angstrom's electric pyrheliometer continued in abeyance owing to shortness of staff.

Aerological Work.

13. In the absence from the Aerological Observatory of both the Director and his Assistant, no examination or publication of the data already collected was possible. Pilot balloon work at three stations in north India and one in the south was continued on the same scale as during 1917 to 1918, and a survey of the winds along the flying route to Rangoon was started by the institution of a flying station at Akyab in February 1919. The preparation of the data for publication was continued. The Observatory provided assistance in connection with the military pilot balloon work of Mesopotamia by supplying hydrogen and apparatus.

Researches by the Simla Staff.

14. Owing to the absence on war work of Simla gazetted officers, the only researches found possible have been statistical examinations of various types.

Seismograph Observations.

15. Seismological observations were recorded throughout the year by two Omori-Ewing seismographs at Simla and at Calcutta and one at Bombay; by Milne seismographs at Kodaikanal and Colaba (Bombay); and by means of other self-registering instruments at the last named station. All the instruments worked satisfactorily throughout the year, and data were transmitted to the Seismological Committee of the British Association.

Marine Meteorology.

16. No change was made during the year in the method of collecting marine information.

At Calcutta and Bombay a clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard, for the purpose of applying the necessary corrections to the readings in the logs; and, after the barometer comparisons have been made, a statement of the error of the ship's barometer is given to the captain, in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port, but it is ample for the purposes of the department.

The data thus obtained are utilised in the preparation of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department, and in drawing up an account of the storms of the year for publication in the Annual Summary.

The arrangement made with Royal Alfred Observatory at Mauritius, for collecting marine data from the Indian Ocean, has been continued, and the thanks of this department are again due to that office for thus supplying a large amount of useful data. No such data were received from the London Meteorological Office during the year.

Snowfall Registration in the mountain districts to the north and west of India.

17. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete, and the thanks of the department are again due to the various officers who have collected and forwarded it. Unfortunately the series of large-scale photographs of the snows, as seen from Simla, which was started in 1905, has had to be discontinued during the war.

Rainfall Registration.

18. The registration of rainfall in India has invariably been carried out by the provincial authorities. In 1889 a uniform system was introduced by the Government of India, and the Director-General of Observatories was made consulting officer in connection with this work. His advice is sought regarding the starting of new rain-gauge stations, and he receives annual reports from the local officers responsible for the registration of rainfall upon the efficiency of the work. A general account of the system, which came into operation in the year 1891-92, will be found on pages 5-8 of the Administration Report of the year 1889-90, and on pages 6 and 7 of the Administration Report for the year 1890-91.

The following is a statement of the number of rain-gauge stations from which data were received for publication in the Rainfall data of India at the end of the year :—

Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1919.	Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1919.
Burma	210	Baluchistan	89
Assam	125	Rajputana	186
Bengal	241	Bombay and Sind	289
Bihar and Orissa	302	Central India	126
United Provinces	274	Central Provinces and Berar ..	189
Punjab	190	Hyderabad	19
Kashmir	39	Mysore	77
North-West Frontier Province ..	35	Madras (including Pudukkottai, Coorg, Travancore and Cochin).	525

The following paragraphs give a brief summary of the reports of the officers in charge of rainfall registration for the year 1918-19 :—

Assam.—The number of gauges inspected was 88, and the total number of inspections was 142 against 82 the previous year. Forty-one rain-gauges were inspected more than once. There was thus a distinct improvement in the matter of inspections compared with the previous year.

Baluchistan.—The number of stations that were inspected is not stated in the report.

Bihar and Orissa.—Out of 305 stations, 181 stations were inspected and 224 inspection cards were received against 219 last year. The rainfall registration work was generally done satisfactorily.

Bengal.—Of the 241 rain-recording stations in the Province, only 41 stations were inspected.

Bombay and Sind.—Out of 278 rain-gauges in British districts, 178 were inspected, 48 being inspected more than once. The total number of inspections was 232 against 304 in the previous year. In Native States, 44 gauges were inspected out of 61 : the total number of inspections amounted to 50.

Burma.—Of 213 rain stations, 18 were meteorological observatories, 25 were in charge of the Public Works Department, 2 in charge of the Agricultural Department, and the rest were under District officers. Of the rain-gauges, 149 were inspected : 122 were in good order, 21 were in fair condition, and 6 were unsatisfactory.

Central Provinces.—There were 146 inspections against 175 the previous year. The results attained during the year are fairly satisfactory and the registration continues to be efficiently done.

Berar.—The number of inspections of the 43 rain-gauges was 127 against 103 in the previous year.

Hyderabad.—The rainfall registering stations of Hyderabad are in charge of the Nizam's Public Works Department. There are 17 stations, of which only 2 were inspected during the year. In addition there is a rain-gauge in charge of the Residency Surgeon and one at Bolaram in charge of the Senior Medical Officer.

Kashmir.—There were 38 rain-gauges in this State, of which 8 are meteorological observatories and the remainder are in charge of the Revenue Department. Ten rain-gauges were inspected as against fourteen last year.

Madras.—Out of 495 rain-recording stations, 395 were in the Madras Presidency, and of these the number inspected was 383. As a result of the systematic inspection in this presidency of late years, defects are rarely noted now in the inspection reports, which means that the rain-gauges are being maintained in good order and that the rain registration is accurate.

Mysore.—At the close of the calendar year 1918, the number of rain-recording stations was 225 : of these, 203 were inspected against 201 inspected last year.

The gauges appeared to be maintained on the whole in a satisfactory condition.

North-West Frontier Province.—The report on rainfall registration contained in the current administration report of land revenue, land records and agriculture of this province, refers to the year 1917-18 and states that there was no change in the number or the situation of the rain-gauges except that a new gauge was sanctioned for Kaghan. These and the rainfall registers are generally reported to be in good order and properly maintained.

Punjab.—The number of rain-gauges in the Punjab was 214, of which 150, are in charge of district officers and 97 in charge of irrigation officers. There were 21 inspections of the district rain-gauges. The process of replacing the old self acting gauges by Symons' gauges continued during the year under report.

Rajputana and Ajmer-Merwara.—During the triennial period ending the 31st March 1919, there were 420 rain-gauges, of which most were inspected during the period under review.

United Provinces.—Out of 270 stations under district and canal officers, 45 per cent. were inspected as compared with 51 per cent. last year and 56 per cent. in 1916-17.

Summary.—In Rajputana, the Central Provinces, Berar, Madras, and Mysore, the proportion of the rainfall stations inspected was over 75 per cent., which is satisfactory. In Assam, Bihar and Orissa, Burma and Bombay, where between 50 and 75 per cent. of gauges were inspected, the efficiency of the system must suffer before long. But the proporti ns in the remaining provinces—Kashmir 33 per cent., Hyderabad 23 per cent., Bengal 17 per cent. and the Punjab 14 per cent.—are such as to call for serious attention.

The System for Storm Warning.

19. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed from the Simla Office by the Director-General of Observatories, and from the Calcutta Office by the Meteorologist, Calcutta.

The following ports are warned from Simla for storms in the Arabian Sea :—

Aden, Karachi, Cutch Mandvi, Jamnagar, Dwarka, Porbandar, Veraval, Jafarabad, Bhavanagar, Daman, Bombay, Alibagh, Murud Janjira, Harnai, Ratnagiri, Malvan, Vengurla, Nova Goa, Marmagao, Karwar, Kumta, Honavar, Mangalore, Tellicherry, Calicut, Cochin, Alleppy, Quilon, Trivandrum, Colachel, Busra and Colombo.

The Meteorologist, Calcutta, warns the following ports for storms in the Bay of Bengal :—

Colombo, Tuticorin, Pamban, Negapatam, Porto Novo, Cuddalore, Madras, Masulipatam, Cocanada, Vizagapatam, Calingapatam, Gopalpur, Puri, Hukitala (False Point), Chandbali, Sandheads, Saugor Island, Diamond Harbour, Mud Point, Budge Budge, Calcutta, Khulna, Barisal, Goalundo, Narayanganj, Chandpur, Noakhali, Chittagong, Cox's Bazar, Akyab, Kyaukpyu, Diamond Island, Bassein, Rangoon, Elephant Point, Moulmein, Tavoy, Mergui, Table Island and Port Blair

The following River Police stations in Eastern Bengal and Sunderbans are also warned :—

Nikli, Bhairab, Chandpur, Mirzaganj, Narayanganj, Madaripur, Gopalganj, Gournadi, Goalundo, Aralia, Sirajgang, Lohajang, Sara, Godagari, Rampur Boalia, Khoksa Kakchira and Tushkhali.

Note.—No signals are hoisted at Tavoy, Noakhali, Calingapatam, Porto Novo or at any of the River Police stations; but the information contained in special telegrams is generally conveyed either to the shipping agents or to vessels lying in the ports.

20. In addition to special messages sent during stormy weather the Meteorologist, Calcutta, provides shipping with daily information regarding the weather over the Bay. The following ports receive daily telegrams under the "General system with additional signals":—

(1) Table Island.
(2) Elephant Point.
(3) Diamond Island.
(4) Akyab.
(5) Chittagong.
(6) Negapatam.
(7) Cocanada.
(8) Madras.
(9) Cuddalore.
(10) Porto Novo.
(11) Bassein.
(12) Rangoon.
(13) Saugor Island.
(14) Sandheads.

Note.—Ports (1) to (12) however receive no telegrams during the period 15th January to 31st March. On the 15th January a telegram is sent to these ports saying the Ball indicating fine weather should remain suspended until further orders. At the Sandheads signals are not exhibited, but information is available for passing vessels.

21. In accordance with resolutions passed at the International Radio-Telegraph Conference held in London in June and July 1912, the Indian Radio-Telegraph coast stations are now supplied with telegrams containing meteorological information with regard to the Arabian Sea and the Bay of Bengal. The messages are sent to the radio stations at Bombay, Karachi, Calcutta, Rangoon, Madras and Port Blair for broadcast transmission by wireless to the shipping in the Arabian Sea and the Bay of Bengal.

Arrangements made for the receipt by wireless telegraphy of meteorological observations from ships at sea worked satisfactorily up to August 1914, when owing to the outbreak of the war these wireless telegrams had to be discontinued.

Warnings for storms in the Bay of Bengal.

22. During the year warnings were issued for eleven disturbances. Two of these were of sufficient intensity to be classed as storms. Below is given a statement of their course and of the action taken.

Storm of 22nd-25th May 1918.

This developed slowly over the Sandheads during the 22nd and 23rd. It began moving almost due east on the 24th and by the morning of the 25th had struck the coast between Cox's Bazar and Akyab. It was of small extent but of moderate intensity.

The action taken with regard to Chittagong, Cox's Bazar and Akyab is shown by the following telegrams :—

Chittagong.

24th May at 11 hrs. 15 mins. Hoist danger signal number seven. Feeble storm one hundred miles south-west Cox's Bazar moving north-east.

24th May at 16 hrs. 9 mins. Storm small but of moderate intensity approaching now sixty miles west-south-west Cox's Bazar moving north-east.

25th May at 11 hrs. 9 mins. Hoist Ball. Storm crossed coast near Cox's Bazar. Fairly strong monsoon over Bay.

Cox's Bazar.

24th May at 11 hrs. 15 mins. Hoist danger signal number seven. Feeble storm one hundred miles south-west Cox's Bazar moving north-east.

24th May at 16 hrs. 6 mins. Lower danger signal number seven and hoist danger signal number six. Small storm of moderate intensity now sixty miles west south west Cox's Bazar.

25th May at 11 hrs. 29 mins. Lower storm signal. Storm crossed coast near Cox's Bazar.

Akyab.

24th May at 11 hrs. 21 mins. Hoist local cautionary. Feeble storm one hundred miles south west Cox's Bazar moving north east.

25th May at 11 hrs. 9 mins. Hoist Ball. Storm crossed coast near Cox's Bazar. Fairly strong monsoon over Bay.

Although the coast observations on the morning of the 23rd showed clearly the existence of the disturbance, no warnings were issued till the morning of the next day : the notice given was thus rather short.

Storm of 16th-21st November 1918.

Unsettled weather appeared over the south of the Bay on the 13th and gradually concentrated into a storm of slight or moderate intensity by the 16th. On the 17th the centre was probably about 200 miles east south east of Negapatam. Thence it travelled roughly in a north north easterly direction and disappeared on the 21st over the north of the Bay. The ports which were likely to be affected or from which vessels might run into the storm were informed daily from the 13th of its progress and signals were hoisted. The action taken with regard to Negapatam, Madras and Diamond Harbour is shown by the following telegrams.

Negapatam.

13th November at 10 hrs. 31 mins. Hoist distant cautionary section five. Depression probably forming one hundred miles west Andamans.

14th November at 10 hrs. 17 mins. Hoist distant cautionary section four. Conditions slightly unsettled two hundred fifty miles off Negapatam.

15th November at 10 hrs. 32 mins. Hoist distant cautionary section four. Weather disturbed south west Bay three hundred miles east Negapatam.

15th November at 22 hrs. 57 mins. Hoist local warning. Slight storm formed off Negapatam moving westwards.

16th November at 11 hrs. Hoist danger signal number five. Storm moderate intensity two hundred fifty miles east Pamban moving west south west; weather stormy whole south west Bay south latitude Madras.

17th November at 11 hrs. 42 mins. Hoist danger signal number seven. Storm moderate intensity two hundred miles east Pamban moving slowly westwards; weather stormy south Madras west Port Blair.

17th November at 18 hrs. 48 mins. Storm seems severe is still east of north end Ceylon and moving slowly westwards.

17th November at 22 hrs. 50 mins. Storm moderate to severe approaching coast near Negapatam likely cross it to-night.

18th November at 10 hrs. 37 mins. Hoist danger signal number six. Storm moderate to severe one hundred miles east Cuddalore this morning, moving in north westerly direction towards Madras.

19th November at 11 hrs. 20 mins. Hoist distant warning sections two four. Moderate storm over two hundred miles east Madras moving north north easterly direction; weather stormy off north Madras and Orissa coasts.

20th November at 11 hrs. 8 mins. Hoist distant warning sections two three. Storm now feeble; centre Bay; latitude Vizagapatam; moving north east; weather squally northern half Bay.

21st November at 11 hrs. 17 mins. Hoist distant warning section one. Storm feeble now; centre Bay; latitude Puri; moving north east; weather squally head Bay.

22nd November at 10 hrs. 21 mins. Hoist Ball. Depression practically disappeared. Weather almost normal again.

Madras.

13th November at 10 hrs. 31 mins. Hoist distant cautionary section five. Depression probably forming one hundred miles west Andamans.

14th November at 10 hrs. 17 mins. Hoist distant cautionary section four. Conditions slightly unsettled two hundred fifty miles off Negapatam.

15th November at 10 hrs. 32 mins. Hoist distant cautionary section four. Weather disturbed southwest Bay three hundred miles east Negapatam.

15th November at 22 hrs. 59 mins. Hoist local cautionary. Slight storm formed off Negapatam moving westwards.

16th November at 11 hrs. 4 mins. Hoist local warning. Storm moderate intensity two hundred fifty miles east Pamban moving westsouthwest; weather stormy whole southwest Bay south latitude Madras.

17th November at 11 hrs. 55 mins. Hoist danger signal number five. Storm moderate intensity two hundred miles east Pamban moving slowly westwards; weather stormy south Madras west Port Blair.

17th November at 18 hrs. 48 mins. Storm seems severe, is still east of north end Ceylon and movingslowly westwards.

17th November at 22 hrs. 50 mins. Storm moderate to severe approaching coast near Negapatam likely cross it to-night.

18th November at 10 hrs. 26 mins. Hoist danger signal number seven. Storm moderate to severe one hundred miles east Cuddalore this morning moving in northwesterly direction towards Madras.

19th November at 11 hrs. 20 mins. Hoist distant warning sections two four. Moderate storm over two hundred miles east Madras moving northnortheasterly direction; weather stormy off north Madras and Orissa coasts.

20th November at 11 hrs. 8 mins. Hoist distant warning sections two three. Storm now feeble; centre Bay; latitude Vizagapatam; moving northeast; weather squally northern half Bay.

21st November at 11 hrs. 17 mins. Hoist distant warning section one. Storm feeble now. Centre Bay; latitude Puri; moving northeast; weather squally head Bay.

22nd November at 10 hrs. 24 mins. Hoist Ball. Depression practically disappeared. Weather almost normal again.

Diamond Harbour.

13th November at 10 hrs. 34 mins. Hoist distant cautionary. Depression probably forming one hundred miles west Andamans.

14th November at 10 hrs. 32 mins. Conditions slightly unsettled two hundred fifty miles off Negapatam.

15th November at 10 hrs. 42 mins. Weather disturbed southwest Bay three hundred miles east Negapatam.

16th November at 11 hrs. 56 mins. Lower distant cautionary. Hoist distant warning. Storm moderate intensity two hundred fifty miles east Pamban moving westsouthwest; weather stormy whole southwest Bay south latitude Madras.

17th November at 12 hrs. 43 mins. Storm moderate intensity two hundred miles east Pamban moving slowly westwards; weather stormy south Madras west Port Blair.

18th November at 11 hrs. 11 mins. Storm moderate to severe one hundred miles east Cuddalore this morning moving in northwesterly direction towards Madras.

19th November at 11 hrs. 50 mins. Moderate storm over two hundred miles east Madras moving northnortheasterly direction. Weather stormy off north Madras and Orissa coasts.

20th November at 11 hrs. 40 mins. Storm now feeble; centre Bay latitude Vizagapatam; moving northeast; weather squally northern half Bay.

21st November at 11 hrs. 45 mins. Storm feeble now. Centre Bay; latitude Puri; moving northeast; weather squally head Bay.

22nd November at 10 hrs. 47 mins. Lower signal. Depression practically disappeared; weather almost normal again.

The warnings were on the whole fairly successful, although from the 15th to the 18th, the Meteorologist, Calcutta, was under the impression that the storm was

going to cross the Coromandel Coast and hoisted signals accordingly: thus the danger signal No. 7 was flying at Madras on the 18th to show that the port was directly threatened and was only lowered on the 19th.

WARNING FOR STORMS IN THE ARABIAN SEA DURING THE YEAR.

23. The Simla Office warns the west coast ports, not only for storms, but also for squally weather, especially at the beginning of the monsoon. There were ten periods of disturbed weather in the Arabian Sea for which warnings were issued, but only one of these disturbances developed into a storm.

This was the development of a depression which had its origin in the Bay of Bengal and was thence transmitted westwards into the southeast of the Arabian Sea on the 1st November. According to the limited marine information available it travelled in a westnorthwesterly direction and passed into Arabia near the Kuria Muria Islands before the morning of the 12th. It would appear to have developed into a storm of considerable severity during its passages over the Arabian Sea.

The ports which were likely to be affected or from which ships might run into the storm were informed daily from the 1st to the 7th and the appropriate signals were hoisted. The signals were lowered everywhere on the 8th, that is, three days before the storm had actually disappeared. The premature lowering of the signals was, however, due solely to the fact that the coast stations failed to show any signs of the continued existence of the storm, which was then far away in the west of the Arabian Sea.

The action taken with regard to Bombay and Aden is shown by the following telegrams :—

Bombay.

1st November at 12 hrs. 20 mins. Approaching unsettled weather, may cause squalls Malabar Coast. Hoist signal number one distant cautionary.

1st November at 22 hrs. 9 mins. Depression from Madras coast slowly approaching.

2nd November at 11 hrs. 56 mins. Weather disturbed Malabar coast but no storm.

3rd November at 12 hrs. Depression from Madras coast passed out into southeast Arabian Sea : at present feeble but may develop.

4th November at 12 hrs. 8 mins. Depression moved west.

5th November at 11 hrs. 58 mins. Depression giving disturbed weather southern half Arabian Sea.

6th November at 11 hrs. 57 mins. Storm probably formed about four hundred miles west of Ratnagiri. Replace distant cautionary by distant warning signal.

6th November at 22 hrs. 30 mins. Storm probably now moving slowly northwest.

7th November at 12 hrs. 5 mins. Depression probably still going slowly northwest.

7th November at 23 hrs. 3 mins. Depression scarcely influencing observatories: so either weakening or travelling away westwards.

8th November at 11 hrs. 48 mins. The depression has ceased affect observatories. Lower signal.

Aden.

3rd November at 12 hrs. 8 mins. Depression southeast Arabian Sea may develop and move west or north. Hoist distant cautionary signal.

4th November at 12 hrs. 5 mins. Depression moved west.

5th November at 12 hrs. 5 mins. Depression giving disturbed weather southern half Arabian Sea.

6th November at 12 hrs. 3 mins. Storm probably formed about four hundred miles west of Ratnagiri. Replace distant cautionary by distant warning signal.

7th November at 12 hrs. 8 mins. Depression about sixtyseven east eighteen north. Probably moving northwest.

8th November at 11 hrs. 50 mins. Depression ceased affect observatories. Lower signal.

INFORMATION IN CONNECTION WITH THE SENDING OF VESSELS TO MESOPOTAMIA.

24. Information regarding weather in the Bay was sent by the Meteorologist, Calcutta, to the Captain Superintendent, Royal Indian Marine Dockyard, Calcutta, in connection with the towage of vessels intended for Mesopotamia. A number of warnings regarding cyclonic weather in the north of the Arabian sea or squally weather in the Persian Gulf were sent from Simla to the Port Officer, Busrah.

FLOOD WARNING AND WEATHER FORECASTS TO DISTRICT, IRRIGATION, RAILWAY AND OTHER OFFICERS.

25. This work is carried out chiefly by the Simla Meteorological Office, and partly by that of Calcutta. The arrangements have been made at various times and differ considerably in character, according to the nature and extent of the flood or weather warnings required by the officers concerned. In most cases these officers require telegrams either warning them of advancing storms likely to give heavy rain, or informing them of the actual occurrence of heavy rainfall likely to give rise to severe floods which might injure railways or canal works; and in other cases, they require warnings or forecasts of the weather for as long a period beforehand as possible.

The number of district officers and officers in the irrigation, telegraph, railway and other departments requiring flood warnings from Simla amounted at the end of the year to 210, as compared with 206 in the previous year. There were also 5 officers of the Telegraph Department who required warnings for strong winds.

This number does not include captains of mail steamers and other vessels who occasionally telegraph from Karachi, Aden and other ports for the latest intelligence respecting the position and movement of cyclonic storms, nor does it include the names of other individuals or firms who ask for special forecasts.

The number of warning messages sent from Simla during the year 1918-19 was 3,605 as compared with 5,789 in 1917-18, 4,879 in 1916-17 and 2,838 in 1915-16.

The number of warnings for heavy rainfall and strong winds sent from Calcutta during the year 1918-19 was 630 and for only strong winds 236, thus making a total of 866, as compared with 1,355 in 1917-18.

26. Instructions were issued by the Government of India in 1898 that every officer to whom storm or flood warnings are issued should, in the month of January of each year or, in the case of military expeditions, at the close of the campaign, forward to the head of this department a brief return of the warnings received and should also report—

(1) whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department;

(2) whether the warnings were timely and satisfactory in every respect and, if not, in what points they were defective;

(3) whether any changes might be made in the system which would make the warnings more useful.

Reports on the ordinary storm and flood warnings for the calendar year 1918 were received from 45 officers. Of these, 32 stated that the warnings were satisfactory, and the remaining 13 offered no remarks.

A comparison of the reports of floods and of heavy rain with information supplied to the various officers would appear to show that the system is working satisfactorily, and that most of the warnings issued were of value to the recipients. As an illustration, the following note may be of interest. It formed part of the report submitted by the Executive Engineer, Rupar Division, Sirhind Canal:—

> "It was a particularly dry season and there were no large floods. The telegrams however were generally useful when sent and on several occasions there was heavy rain over the catchment area, in the hills when we had only light rain near Rupar and the telegrams gave us timely warning that a rise in the river could be expected."

SEASONAL FORECASTS.

27. The forecast for the monsoon period of 1918, dated the 8th June, was sent to Local Governments and Administrations, communicated to the press, and printed

in the Gazette. A statement of the rainfall of June and July with a forecast for August and September was drawn up on the 7th August 1918 and published in a similar manner.

A statement of the actual rainfall during the monsoon period and a comparison of the two forecasts with actual rainfall was drawn up on the 4th January 1919 and sent to Local Governments and Administrations.

The following are summaries of these two forecasts and comparison of them with the actual rainfall :—

Forecast, dated the 8th June 1918.	Remarks.
(*a*) The monsoon rainfall of Upper Burma and northeast India is likely to be in excess.	The percentage departures of monsoon rainfall were—9 in Upper Burma, +29 in Assam, +17 in Bengal, —13 in Orissa, —6 in Chota Nagpur and + 16 in Bihar. The average of these is + 6.
(*b*) In the remainder of India, excluding Lower Burma and the south of the Peninsula, the outlook is roughly normal though slightly perhaps on the unfavourable side.	Apart from the east of the Central Provinces, where the total rainfall was normal, it was everywhere in moderate or large defect ; the worst cases were Punjab 51%, Sind 81%, Rajputana 59% and Bombay 53 %.
(*c*) The rainfall of northwest India is not likely to be affected prejudicially by accumulations of snow in the Himalayas.	The rains in northwest India extended early to the frontier and there was no evidence of local snowfall effect.

Forecast, dated the 7th August 1918.	Remarks.
(*a*) Prediction is unusually difficult in a season in which the strongest monsoon on record in May has been followed by the weakest monsoon on record in July ; but although the outlook is not favourable there are grounds for expecting an improvement in the general rainfall of India.	After a percentage defect over India of 24 % in the first half of the monsoon period, the rainfall of August was in defect by only 3%, that of September being in defect by 27%. For the second half of the period the defect was 13% and there was a decided improvement.
(*b*) Apart from northeast India and Burma the area most likely to get a good percentage of its usual rainfall in August and September is the Central Provinces ; and the prospects are least good in northwest India, including the greater part of the United Provinces, the west coast regions and Madras.	The total rainfall of August and September was in excess in Burma, Assam, Bengal and Bihar and Orissa. In other provinces there was a defect of the following percentage amounts :—

United Provinces	39	Central India	27
Punjab ..	39	Central Provinces.	29
North-West Frontier Province	30	Hyderabad	36
Sind	55	Mysore ..	26
Rajputana ..	45	Madras ..	30
Bombay ..	37		

Thus apart from northeast India and Burma the percentage was least bad in Central India, the Central Provinces, Mysore and Madras. It was worst in northwest India and the west coast.

It will be seen that in June the forecasts (*a*) and (*c*) proved correct, but (*b*), which was by far the most important of all, was wrong. In August both (*a*) and (*b*) proved on the whole correct. The failure of the monsoon was associated with low pressure in the Argentine and Chile, and high pressure in the Indian Ocean; but though it was apparently produced in the usual way it did not give the usual indications in advance. In these respects as in some others it resembled the monsoon of 1907.

28. A forecast of the probable character of the rains during January and February 1919 was prepared on the 4th January 1919 and issued in the same manner as the forecast of the previous June. On the 10th July 1919 a comparison of the actual precipitation with the above forecast was issued. The summary of the forecast issued was :—

> "The indications suggest that the total rainfall of northwest India in January and February and the snowfall on the neighbouring hills will be roughly normal."

The forecast was not correct, as the rainfall of the period in the plains was in large excess, and the snowfall in the hills was also above normal.

Daily Telegraphic Weather Summary.

29. The summary was despatched daily at about noon. It was exhibited at certain telegraph offices and sent to 85 officers of Government. The subscribers for longer or shorter periods were 10 newspapers and 90 private individuals. To officers in Simla, sheets containing the summary with a chart showing the rainfall of the day are distributed by hand.

Publications.

30. There were no changes made during the year in the form of the routine publications of the department, of which a description will be found in the departmental administration reports of 1907-08 and 1910-11. Publication of the Monthly Weather Review and of the Annual Summary, which had been stopped during the war on account of the shortage of paper, was resumed towards the end of the year.

The monthly and annual supplements to the Indian Daily Weather Report have been printed as usual, and supply the general need for prompt information.

Supply of Meteorological Information.

31. In addition to the meteorological information published by the department, special information was supplied to the Meteorological Departments of England, Australia and Egypt.

> Climatological information, at times involving special calculation, is also provided for sanitary and other officers of Government, as well as for private firms who are willing to pay the expense necessarily incurred. The extent to which the department is utilised in this manner will be seen from the chart appended.

Medical Department.

The department has also supplied information in connection with cases of heat-stroke among British soldiers. The highest wet bulb temperatures of the days were required, but as most of the departmental observatories recorded readings at 8 hrs. only, these maximum temperatures had to be deduced approximately from other readings by applying corrections. During July wet maximum thermometers were started at six cantonments in northwest India and information was furnished to the local military authorities whenever the maximum wet bulb temperature reached the danger limit (80°).

Miscellaneous.

32. Three hundred and fiftyone books and pamphlets, either purchased or presented by scientific bodies, were added to the library during the year, as against four hundred and eleven in the year 1917-18.

Six libraries, observatories or societies were added during the year to the list of institutions to which the publications of the Indian Meteorological Department are supplied, and one was removed; the number on the list is now 376.

Chief Features of the Year.

33. The activities of the department were very much curtailed throughout the year owing to the absence on war duty of a large number of the senior officers. Dr. Simpson and Mr. Normand of the Simla office were absent on war work throughout the year. Both Mr. Field, the Director, and Mr. Harwood, the Assistant Director of the Agra Aerological Observatory, were absent for the same reason for the greater part of the year. Dr. Royds, the Assistant Director of the Kodaikanal Observatory, was employed under the Director of Ordnance Factories throughout the year. Thus, of the seven members of the European staff of the department, five were absent for the whole or the greater part of the period under review. To meet this reduction, the scientific work of the department had to be reduced to a minimum but the routine work was continued with but little change.

The publication of the Monthly Weather Reviews which had been discontinued owing to the war was resumed near the end of March.

Arrangements were made for the military authorities at six cantonments in northwest India to be informed when the wet bulb temperature reached 80°; it having been found that when the wet bulb temperature is above this value the danger of heatstrokes is very great.

The department has also had under consideration two schemes which will have an important bearing on its working in the near future. Firstly, it has been found necessary to consider the removal of the Colaba Observatory from its present site owing to the expansion of the Bombay Harbour Defence Works. The necessity for the removal and possible sites to which the observatory can be transferred have received careful consideration and it has been recommended to Government that the observatory should be removed to a new site. Secondly, the needs of the military air service in India and the international convention regarding aviation have necessitated the department taking into consideration the inauguration of a special meteorological service for aviators. The upper air observations already taken in connection with the aerological work of the Agra Observatory have been found of considerable use ; but observations over a much expanded area will be required in the future. Methods of undertaking this new work were being discussed at the end of the year under review.

Concluding Remarks.

34. The Meteorological Department owes a large part of its usefulness to the sympathetic assistance it receives from outside departments. Civil Surgeons and other officers of Government departments, as unpaid superintendents of observatories and in other capacities, help in the meteorological work ; the Telegraph and Postal Departments assist in every way in the rapid transmission of meteorological information, at the same time that they allow their employees to act as observers. The Indo-European Telegraph Department, also, by giving free transit to the daily records of the Persian observatories, places a large amount of most useful information at the disposal of the Meteorological Department. Weekly telegrams were received from May to September from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams give valuable information of the weather conditions in the Indian Ocean and the department is indebted to the officers indicated for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the Indian Meteorological Department.

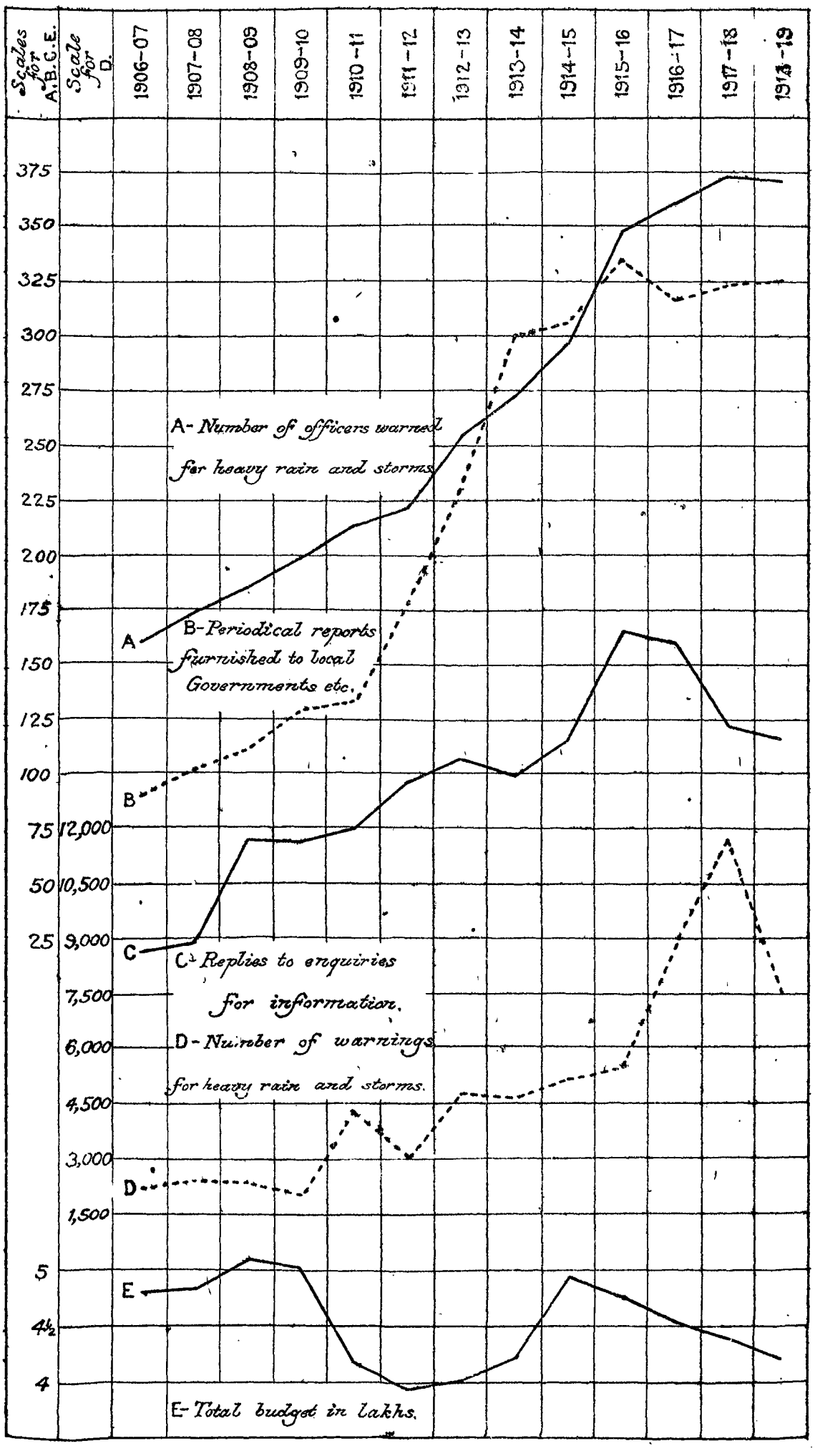
The department is greatly indebted for important information as to meteorological conditions prevailing antecedent to and during the southwest monsoon to the Director, Physical Service, Survey Department, Cairo ; the Directors of the Observatories at Buenos Ayres and Santiago ; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

Simla ; G. C. SIMPSON,

The 19th September 1919. *Officiating Director General of Observatories.*

G. M. Press, Simla.—No 1 D.G. of Ob.—20-10-19 -300—K.C.M.

GROWTH IN DEPARTMENTAL ACTIVITY AND CHANGES IN TOTAL COST



REPORT ON THE ADMINISTRATION OF THE METEOROLOGICAL DEPARTMENT OF THE GOVERNMENT OF INDIA IN 1920-21.

CHIEF FEATURES OF THE YEAR.

1. The department has suffered seriously during the year owing to the transfer of Dr. G. C. Simpson and the death of Rai Bahadur Hem Raj. Dr. Simpson was absent on deputation in Egypt for service on the Nile Commission from January to June and after that left for England where he had been appointed Director of the Meteorological Office under the Air Ministry. He will be greatly missed as he combined scientific qualifications of an extremely high order with exceptional administrative capacity. He had made notable contributions to our knowledge of weather, and would have been of the greatest value to India during the next fifteen years in securing the continuous development which is necessary in order that science shall render its maximum of effective service to the State. The death of Rai Bahadur Hem Raj, who possessed a unique knowledge of Indian weather, was a direct outcome of his devotion to duty. Throughout the war in spite of poor health he carried on an exceptionally large share of the routine work, and when his health gave way completely in October 1919, it was too late for remedial measures to be of avail. Neither of these vacancies has been filled up and the shortage of gazetted staff in the Simla office has been as serious as it was during the war years. In consequence it has been impossible to make much headway against the arrears produced by war conditions, various handbooks are much needed and observatories cannot be adequately inspected. The situation must cause considerable anxiety; for it is not easy to restore accuracy and efficiency when it has been lost, and experience has shown that a single wrong reading of a barometer may lead to a false conclusion as to the position or violence of a storm, and may produce serious results to life and property.

Shortly before the war a system had been organised for collecting weather observations from ships by wireless telegraphy. The information as to the development and path of storms that is distributed by wireless to vessels at sea and sent to the Port Officers along the coast would then be much more reliable and complete than that deduced solely from our land observations. Ships were, however, not permitted to send wireless messages during the war and the system was closed down. Arrangements for starting it again were made in May 1920, and the system is by degrees being adopted: at times the information is of great value.

The warnings for ports and shipping in the Bay of Bengal and Arabian Sea were carried out on the whole successfully. For the three storms which formed in the Bay the warnings were early and correct. In the Arabian Sea the only storm was that of the 6th to the 13th June, which produced dangerous seas and hurricane winds, and passing inland caused great damage to property in Kathiawar. Its existence was early recognized and full warnings were sent not merely to the ports but also to the administrative heads of the inland districts affected. On the morning of the 9th, however, when the storm was at its farthest from the Indian coast, wrong deductions were made about its direction of movement and the warnings issued were rather misleading. But in the absence of wireless information from ships at sea at the time the inferences made on the 9th were inevitable.

The responsibilities of the department have been greatly increased in recent years by the initiation of military flying on the part of the Royal Air Force in north-west India, and by the need of obtaining information for the use of civil aviators when the route Bombay-Calcutta-Rangoon is opened. Upper air observations have been made regularly at Agra, Lahore, Simla and Bangalore: similar work at Akyab, Calcutta and Bombay was discontinued in August on account of shortage of money. Later in the year extra expenditure for each station was sanctioned but they could not then be resumed for want of trained staff. Stations were also needed at Peshawar and Quetta on behalf of the large number of military aviators flying in north-west India without the information which is generally accepted as necessary in order to safeguard life as well as costly equipment. The

stations were sanctioned and observers have been trained for them: work will be begun as soon as accommodation can be secured.

It was decided in 1919 that the Colaba Observatory should be transferred to the Sion Fort and plans were prepared for the new buildings. Since then, however, the decision to establish the Bombay aerodrome at Juhu has made it advisable to transfer the Meteorological Office to the neighbourhood of the aerodrome; and plans for a combined Office and Observatory at Juhu under the single control of the Director of the Observatory are being prepared at Bombay.

A chart at the end of the report illustrates the general changes in activity and in the budget provision of the year.

Changes in the staff during the year.

2. Dr. G. C. Simpson, whose services had been placed at the disposal of the Upper Nile Irrigation Commission up to the 10th July, was granted privilege leave for 1 month and 26 days with effect from 11th July 1920. His leave expired on the afternoon of the 5th September 1920, and on the following day he took over charge of his new appointment under the Air Ministry in London as Director of the British meteorological service.

Rai Bahadur Lala Hem Raj, Imperial Meteorologist, died on 18th April 1920.

Mr. M. G. Subrahmanyam, B.A., LL.B., Assistant Meteorologist, was granted privilege leave for 5 months and 8 days with effect from 10th December 1920. Mr. V. Doraiswamy, B.A., acted for him.

Mr. S. Sitaramayya, B.A., Scientific Assistant, was granted privilege leave for 1 month and 10 days from 1st November 1920. Mr. V. Doraiswamy, B.A., acted for him.

Mr. W. A. Harwood was granted privilege leave for 3 months and 16 days and in continuation leave on medical certificate for 8 months and 14 days with effect from 13th October 1919. Mr. Shamshad Ali Khan, M.Sc., acted for him from the forenoon of the 8th May 1921.

Mr. T. K. Chinmayanandam, M.A., Director, Bombay and Alibag Observatories, was granted privilege leave for 1 month and 7 days from 24th September 1920. Mr. Mukand V. Unakar, B.A., acted for him. Mr. T. K. Chinmayanandam was transferred to Simla temporarily from the 26th November 1920 to the 25th March 1921 for training in daily weather work; he carried out in addition the duties of the Director, Bombay and Alibag Observatories.

Mr. J. Evershed was granted privilege leave for 5 months and 24 days combined with special leave for 27 days with effect from 25th May 1920. Dr. T. Royds acted for him.

Dr. T. Royds was granted privilege leave for 4 months and 5 days and in continuation furlough on average salary for 4 months and ordinary furlough for 3 months and 26 days (total 12 months) with effect from 25th February 1921.

Mr. Edward Barnes, B.Sc., who had temporarily become Meteorologist, Madras and Deputy Director, Madras Observatory, on the retirement of Mr. R. Ll. Jones from 10th March 1920, was granted leave without allowances for two months from 1st May 1920; Mr. P. C. Chidambara Iyer acted as Meteorologist and Mr. C. Chengalvaraya Mudalier acted as Deputy Director, Madras Observatory.

Dr. E. P. Harrison on returning from combined leave on 10th July 1920 resumed charge of the duties of the Meteorologist, Calcutta.

Revision of pays of establishment and gazetted staff.

3. Proposals for the revision of the pay of the gazetted staff were made in June 1920, but no definite decision had been arrived at by the end of the year. Nor had scales of pay been fixed for the posts formerly held by Dr. Simpson and R. B. Hem Raj. Consequently the Simla office remained understaffed in officers throughout the year. A proposal for the appointment of a new officer to deal with the new demands made by aviation was not sanctioned.

A scheme for the revision of the pay of practically the whole establishment was sanctioned, after considerable alteration, by Government in October 1920. As the majority of the clerks in the Bombay Meteorological office and the Bombay observatory suffered a decrease of income on account of the revision, Government were asked to reconsider their decision with regard to these establishments. The clerks in the Simla office have now been classified into an upper and a lower division, with time-scales of pay similar to those given to corresponding ranks in other attached offices, except that our upper division clerks have been granted a somewhat lower maximum for their scale. A revision was also made in the allowances paid to all the part-time observers serving the department. The great majority of these are third class observers, whose allowance had been fixed some 40 years ago at Rs. 10 a month and had never been changed. The allowance has now been raised to Rs. 15 a month.

The System for Storm Warning.

4. The work of warning Indian ports of the approach of cyclonic storms or of bad weather is performed from the Simla Office by the Director-General of Observatories, and from the Calcutta Office by the Meteorologist, Calcutta.

Thirty-two ports are warned from Simla for storms in the Arabian Sea, and forty-one ports from Calcutta for storms in the Bay of Bengal; many River Police stations in south Bengal are also on the list of warnings. In addition to these special messages sent during stormy weather the Meteorologist, Calcutta, provides shipping at fourteen ports with daily information regarding the weather over the Bay, the information being conveyed by means of a special system of 'additional' signals. Shipping at sea is also supplied with the latest information regarding the weather by means of wireless messages, which are transmitted twice daily from the radio stations at Bombay, Karachi, Calcutta, Rangoon, Madras, Port Blair, Matara, Ceylon and Aden. The weather bulletins from Matara and Aden were started on the 20th March 1920 at the request of the admiralty. A complete account of the warning system may be found in the "Code of Storm Warning Signals for use at Indian Ports."

Warnings for storms in the Bay of Bengal.

5. During the year warnings were issued for sixteen disturbances but none of the sixteen was severe. During four of them (18th-21st June, 21st-23rd July, 5th-6th August 1920 and 10th-13th January 1921) winds over the sea reached gale force and correct warnings were issued in connection with the first three which were only slight cyclonic storms. During the January disturbance, however, though suitable signals were hoisted on the 10th, they were lowered on the 11th and were not hoisted again, though ports near the south-west of the Bay were informed on the 12th about the existence of disturbed weather in that area. Though winds rose to gale force this disturbance did not develop into a cyclonic storm with a definite circulation around its centre.

Warnings for Storms in the Arabian Sea during the year.

6. The Simla Office warns the west coast ports, not only for storms, but also for squally weather, especially at the beginning of the monsoon. There were eight periods of disturbed weather in the Arabian Sea, for which warnings were issued, and one of these at the beginning of the monsoon developed into a storm of great intensity. The warnings for this storm are described below. In all cases the information was issued to ports and to shipping with as much promptness and accuracy as was possible.

Storm of 6th-13th June 1920.

The monsoon arrived on the Malabar coast on June 2nd and advanced northwards very slowly, preceeded by the usual area of squally weather over the Arabian Sea. In this area, as frequently happens, a severe storm developed. Its formation was probably complete on the 6th with centre off the Canara coast about 14°N and 70°E. Its history during the next three days cannot be determined accurately, as we have received no information from ships near its centre. The indications are, however, that the storm advanced in a north-north-westerly direction increasing steadily in intensity. On the morning of the 8th its centre probably lay near

18°N and 68°E. After this its behaviour for a storm of this season was unusual; for it changed its course to north and north-east, and began to advance towards the Kathiawar coast. Also, whereas storms of this type generally move very rapidly on approaching the coast and dissipate quickly inland, the present storm moved remarkably slowly, covering a distance of less than 100 miles during the 36 hours ending 8 A.M. of the 11th, when it lay some 20 miles south-west of Veraval; it crossed the coast in the neighbourhood of Veraval during the day still moving very slowly, and on the morning of the 13th its centre was not far from Rajkot. During the whole of this period the storm had all the characteristics of the destructive cyclones which from time to time visit India, except that it appears to have had no sharply defined calm centre surrounded by a region of hurricane winds; yet the deficiency at the centre, when near Veraval, was about 1·4". The storm rapidly weakened after the 13th and disappeared on the morning of the 15th over north Gujarat. The severity of the storm at sea is best told by the following extracts from ships' reports.

Report from the Master of s.s. "Rotenfels" bound from Basra to Bombay.—I estimate centre passed east of me early on the morning of June 11th, and from 8 A.M. to noon the violence of the sea and its irregularity baffles description. The north-west squalls on the morning of June 11th blew the ship bodily to the south-east at about 4 miles an hour, in their strength; and this carried ship right down into the disturbed area left by the actual central sea as it passed to the east of me. The ship was in ballast and at times was in a most critical condition.

From log of s.s. "Chakdina" bound from Basrah to Bombay.—10th June; noon; position 21°N 67°E. Dull, hazy and overcast. Strong winds, heavy confused sea, ship pitching and straining heavily.

11th June; noon; position 19°N, 70°E. Very strong gale with squalls of hurricane force. Constant rain. Very high confused sea. Vessel rolling and pitching heavily and frequently shipping water.

Report from s.s. "Gairsappa" bound from Karachi to Bombay.—

June 9th.—Left Karachi at midnight.

June 10th.—Light breeze increasing in force.

June 11th.—Moderate gale, wind still increasing in force with direction north-east at 8 A.M. At midnight blowing full gale, north-west, rough high sea.

June 12th.—Blowing whole gale, terrific furious squalls continuous for twelve hours wind W. At midday rain eased off and gale slightly moderating, wind south-west.

June 13th.—Fine and clear but strong south-west wind and rough sea till reaching Bombay at 6 A.M.

Some account may now be given of the severity of the storm over Kathiawar. The Political Agent, Sorath, gives the following account of Veraval's experiences :—

Veraval, a seaport town of the Junagadh State, was from the 9th to the 14th of June the centre of a cyclone the intensity of which has never before been witnessed by the oldest inhabitants of the Peninsula. Thanks to the timely warning of the meteorological survey of the Government of India the seafaring and mercantile communities were enabled to meet what was predicted as the burst of the monsoon. On the 6th of June the barometer commenced to fall reaching 29·718 on the 9th. On the latter day a strong wind commenced to blow from the south-east resulting in high seas and rain in torrents. On the 12th the wind veered round to the north-east and increased in velocity reaching a maximum of 96 miles per hour and continuing with unabated fury until the 14th. During the five days rain to the extent of 28 inches fell, the maximum fall being 11 inches on the 13th. The creeks and rivers in the neighbourhood unable to contain the tremendous volume of water proceeded to pour their contents into the unfortunate town, the streets of which in a very short time became canals. Considerable damage was done to the houses of the poorer communities, but, thanks to the prompt measures of relief taken, there was no loss of life to human beings and the minimum loss to animals. Fortunately the State buildings situated in the town were built on high plinths and formed a refuge to the many hundred rendered homeless. The country craft which form the shipping of Veraval had fortunately been beached some days before the arrival of bad weather and weathered the storm undamaged. Considerable damage was done to cotton bales, grain, tobacco and cereals which were stored in godowns at the Port, the corrugated iron roofs of which were torn off and cast into the streets. The new labour works fortunately suffered little damage although the seas breaking over the newly constructed breakwater washed away immense slabs of stone placed in readiness to continue the extension of the breakwater. The State bungalows situated

about a mile to the west of the town which were mostly unoccupied met the full force of the gale and were considerably damaged. During the course of the cyclone all communication by railway, road and telegraph was completely severed and not restored until the 16th.

Sir E. Maconachie, the Agent to the Governor-General, wrote as follows :—

At Rajkot on the day preceding the storm there was a strong wind from the east. Early on the morning of the 12th June, it started blowing strongly from the north and the wind blew with hurricane violence for the next 24 hours from that direction. From the early morning of the 13th June, the force of the wind gradually decreased and changed to the west. There was no indication of any calm centre and so long as the gale lasted the direction was steady from the north. I lost 54 trees in my compound alone and have never during 31 years in India seen a storm at all approaching this one in intensity.

Mr. Doraiswamy, head clerk of the Bombay Meteorological office, happened to be in Rajkot from the 11th to the 13th June and the following notes are taken from his inspection report :—

I got orders to leave Rajkot on the evening of the 11th, but finding it impossible to leave that night I went to the observatory and took some readings of the barometer. The wind was very high at 20·46 and the anemometer could not be read. It was blowing a gale between 21·30 and midnight. It moderated somewhat after this, but increased again after 7 A.M. in the morning of the 12th. At 6 A.M. I went up and read the anemometer, and the velocity was 34 miles an hour. I left the observatory at 7 A.M., but finding that no trains were running, went back to the observatory at 11 A.M.

The wind was blowing a gale throughout the day and many big trees were blown down. At its height the average velocity of the wind would have been about 60 miles an hour and individual gusts must have attained a much greater force. The anemometer was not read throughout the day. After midnight it moderated, but even on the morning of the 13th the wind velocity was 40 miles an hour. The thermometer shed was, as I expected, blown down.

During the storm's first two days over the land great damage was done to buildings, trees, cattle, grain and other stocks over a large part of Kathiawar; and all communication by road, rail and telegraph was broken down. Mainly owing to the precautions taken on our telegraphic warnings issued on the 10th and 11th, there was practically no loss of life. The only deaths reported being three killed by the collapse of a building at Savarkundla, four by a similar cause in the Kodinar Mahal of the Amreli Division of Baroda and two from the effects of inclement weather.

The total damage to property in the Kathiawar States and in the Amreli Division of the Baroda State amounted to about 32 lakhs of rupees. Junagadh State into which the storm passed from the sea was the greatest sufferer; the extent of the damage done there by the storm may be gauged by the fact that 16,000 houses fell, 22,000 trees were uprooted and 7,700 cattle died.

A couple of days after the storm subsided, the tide in the Gulf of Cambay rose to the highest level previously recorded and it rose still higher on the 17th and 18th June, reaching to one foot above the previous maximum. Thirty-one villages in the Ahmedabad and Broach districts were flooded and their lands were reported to have been rendered unfit for cultivation. The wells and tanks in these villages were also rendered useless. In the former district the damages to the sea wall in Gogho Mahal is estimated at Rs. 1,50,000 and to private property at Rs. 85,000. The Kaira district also suffered to the extent of Rs. 5,500.

The warnings issued to the districts affected by the passage of the storm over the land are illustrated by the following messages telegraphed to the Agent to the Governor-General, Rajkot and to the Collector, Kaira :—

To Rajkot.

10th June, 11-48.—Think advisable warn you that storm will cross Kathiawar coast this afternoon and give strong winds Rajkot to-night but hills are likely to break it up so that devastating winds are unlikely there.

11th June, 12-50.—Storm now passing slowly inland near Veraval. Rough weather likely for twenty-four hours in exposed areas.

(In addition Rajkot received copies of all the telegrams sent to Veraval. The inhabitants of Rajkot were warned of the approach of the storm by beat of drum.)

1DGofOb

To Kaira.

12th June, 11-30.—Storm of considerable severity passing over Rajkot at eight this morning likely travel over Cambay. It may give very strong winds Kaira and Cambay to-day and cause loss of life especially on rivers.

12th June, 17-52.—Information from Kathiawar is cut off but data from Gujarat show that the storm is moving extremely slowly and probably weakening slowly. It is likely that conditions will not be worse to-morrow than now but as the storm might move rapidly precautions still appear necessary.

13th June, 5-40.—Communications Kathiawar still interrupted. Gujarat data indicate storm centre still over Kathiawar moving very slowly eastnortheasterly direction and very slowly weakening; precautions still appear necessary.

14th June, 12-23.—Storm has almost disappeared; consider precautions no longer necessary.

The action taken with regard to warning the ports along the west coast is shown by the following telegrams issued to Bombay and Veraval:—

To Veraval and Bombay.

6th June at 12 hrs. 25 mins.—Weather squally off Canara owing to depression in which storm perhaps forming. Hoist distant cautionary signal number one.

7th June at 11 hrs. 20 mins.—Storm probably slight off Ratnagiri. Moving north or north-west. Lower distant cautionary and hoist distant warning signal number two.

7th June at 17 hrs. 11 mins.—Storm travelling northwards unable to determine its intensity centre perhaps two hundred fifty miles westsouthwest of Bombay.

8th June at 10 hrs. 40 mins.—Storm probably severe near centre Arabian Sea probably moving northwest.

8th June at 17 hrs. 8 mins.—Storm in centre Arabian Sea still moving slowly westwards.

To Veraval.

9th June at 5 hrs. 36 mins.—Storm apparently about centre Arabian Sea latitude twenty moving northwest too distant from coast to estimate severity.

9th June at 11 hrs.—Storm probably severe probably approaching Arabian coast about latitude 21°.

9th June at 23 hrs. 27 mins.—To-night's observations indicate storm still severe near centre Arabian Sea about latitude 21° now moving in a northerly direction.

10th June at 8 hrs. 10 mins.—Storm centre probably about two hundred miles westsouthwest of Veraval travelling north or northeast may cross Kathiawar coast this evening. Hoist warning signal number four.

10th June at 10 hrs. 45 mins.—Storm moderate intensity will cross coast near you very shortly. Hoist danger signal number seven.

10th June at 17 hrs. 4 mins.—Storm of great intensity centre now about eighty miles west of Veraval moving slowly north may cross coast near Dwarka between midnight and sunrise. Hoise great danger signal number nine.

11th June at 8 hrs. 19 mins.—Storm remains practically stationary close to Kathiawar coast. No information from Veraval where severity is probably greatest.

11th June at 13 hrs. 14 mins.—Storm moving extremely slowly. Rough weather likely for twenty-four hours.

(Communication with Veraval was interrupted between the 11th and 13th.)

14th June at 11 hrs. 29 mins.—Storm passed inland and dissipating. Lower signal.

To Bombay.

9th June at 5 hrs. 30 mins.—Storm apparently moving northwest too distant from coast to estimate severity ships leaving your port now unlikely encounter it. Lower distant warning signal.

9th June at 12 hrs. 7 mins.—Storm probably severe probably approaching Arabian coast about latitude 21°.

10th June at 11 hrs. 37 mins.—Storm moderate intensity close Kathiawar coast crossing inland to-night. Stormy winds and rough seas likely till to-morrow morning. Hoist distant warning number two.

10th June at 17 hrs. 1 min.—Storm of great intensity now about eighty miles west of Veraval moving slowly north may cross coast near Dwarka between midnight and sunrise.

10th June at 23 hrs. 35 mins.—Storm practically stationary close to Kathiawar coast.

11th June at 8 hrs. 19 mins.—Storm remains practically stationary close to Kathiawar coast. No information from Veraval where severity is probably greatest.

11th June at 12 hrs. 30 *mins.*—Storm now passing slowly inland near Veraval. Rough weather likely for twenty-four hours off Kathiawar.

11th June at 16 hrs.—Storm still moving slowly centre probably near Porbandar not yet crossed coast.

11th June at 23 hrs. 15 mins.—Storm centre probably now inland near Rajkot gales around Kathiawar coast likely continue another twelve hours.

12th June at 6 hrs. 51 mins.—Storm still severe but centre now certainly inland near Rajkot. Lower Signal.

On the evening of the 8th and the morning of the 9th the storm centre was judged from the coast observations to be moving from the centre of the Arabian Sea westwards towards the Arabian Coast. Actually, as stated above, the storm centre was probably never farther west than long. 67°E, and during the night of the 8th-9th its path was altering in direction from northwest to northeast. In the light of the subsequent fuller information, therefore, the suggestion to Bombay on the morning of the 9th to lower the warning signal was wrong; similarly it was misleading to broadcast from the Karachi and Bombay radio stations at 13 hours on the 9th the message "storm probably severe probably approaching Arabian Coast latitude twenty-one." This might have proved a costly mistake as the s. s. "Rotenfels" acted on this information in the hope of avoiding the storm area and in consequence ran straight into it with the result indicated above. In the absence of wireless messages from ships at sea to show the unusual track of the storm, the inferences drawn in the night of the 8th-9th from our observatories were naturally based on the supposition that the storm was moving as such storms have moved in the past. With the arrangements now in force for gathering information by wireless from ships, the likelihood of a similar error in future has been greatly diminished.

Flood Warning and Weather Forecasts to District, Irrigation, Railway and other officers.

7. This work is carried out chiefly by the Simla Meteorological Office, and partly by that of Calcutta. The arrangements have been made at various times and differ considerably in character, according to the nature and extent of the flood or weather warnings required by the officers concerned. In most cases these officers require telegrams either warning them of advancing storms likely to give heavy rain, or informing them of the actual occurrence of heavy rainfall likely to give rise to severe floods which might injure railways or canal works; and in other cases, they require warnings or forecasts of the weather for as long a period beforehand as possible.

The number of district officers and officers in the irrigation, railway and other departments requiring flood warnings from Simla amounted at the end of the year to 226. There were also 6 officers of the Telegraph Department who required warnings for strong winds.

The number of special forecast and warning messages sent from Simla during the year was 2,994 and from Calcutta 929.

Instructions were issued by the Government of India in 1898 that every officer to whom storm or flood warnings are issued should, in the month of January of each year or, in the case of military expeditions, at the close of the campaign, forward to the head of this department a brief return of the warnings received and should also report whether the warnings were satisfactory and whether any changes might be made to increase the usefulness of the warnings.

Reports on the ordinary storm and flood warnings for the calendar year 1920 were received from 41 officers. Of these 22 stated that the warnings were satisfactory, and the remaining 19 offered no remarks.

A comparison of the reports of floods and of heavy rain with information supplied to the various officers would appear to show that the system is working satisfactorily, and that most of the warnings issued were of value to the recipients. As illustrations the following extracts from reports may be of interest :—

The Executive Engineer, Rupar Division, Sirhind Canal, wrote :—

" The monsoon of this year was particularly light and very few telegrams were received. Those received were accurate and helpful."

The Sub-Divisional Officer, Workshops, Dehri, reported that :—

" These telegrams (of the 30th and 31st July 1920) gave timely warning of a coming flood, specially so, as the canal had to be closed in the night of the 31st July 1920."

" This telegram (of the 6th August 1920) gave warning for another flood which came down at midday of 7th August 1920."

The Chief Engineer, Indus River Commission, stated that :—

" The warnings are satisfactory and timely in every respect and no change in the system is wanted. I appreciate the care and regularity with which these warnings are issued by the Meteorological Department."

Supply of Meteorological Information.

8. In addition to the meteorological information published by the department, special information was supplied to the Meteorological Departments of England, Australia and Egypt. Climatological information, at times involving special calculation, is also provided for sanitary and other officers of Government as well as for private firms who are willing to pay the expense necessarily incurred. The extent to which the department is utilised in this manner will be seen from the chart appended.

Medical Department.

As in previous years the department has supplied information in connection with cases of heat-stroke among British soldiers. As information was required whenever the wet bulb temperature rose above 75° and as most of our observatories recorded readings at 8 hours only, wet maximum thermometers were maintained at nine cantonments in north-west India and the readings were supplied daily to the local medical authorities from May until September. The readings were also telegraphed daily to Simla and transmitted immediately to Army Headquarters, Medical Branch.

Information to Aviators.

Forecasts were issued, up to the end of September, to the squadrons at Risalpur, whenever the weather became disturbed on the frontier. At the request of the Officer Commanding, Royal Air Force a change was then made in the system of warning, and from 1st October general forecasts for north-west India with a summary of the existing upper winds have been telegraphed daily to Royal Air Force Headquarters, who distribute the information to all squadrons concerned.

Upper Air Work.

9. Work with pilot balloons was continued at several stations under the direction of the Agra Upper Air Observatory. The shortage of funds which resulted from a general revision of pay necessitated the closing of the balloon stations at Akyab, Calcutta and Bombay, and caused the loss of several trained members of the staff. Nevertheless, with both officers present during the last six months of the year, it was possible to make some headway in the discussion of the upper air data of cloud, wind and temperature, which were gathered during the war years.

Experiments on the relative merits of different types of exposure of thermometers were continued.

Researches by the Simla Staff.

10. Shortness of staff prevented any of the gazetted officers from carrying on the preparation of type maps for daily forecasting.

The methods of forecasting for the cold weather rains as well as for the monsoon have been advanced a stage further. The best result is that for the monsoon rainfall of the Peninsula for which a formula based on 45 years' data of only three factors yields a correlation coefficient of ·73.

An investigation was made into the application of wet bulb temperatures in thermodynamical problems and some important conclusions were arrived at about the relationship between wet bulb temperatures and adiabatic processes in the air.

A short discussion on dust-raising winds was prepared for publication.

Observatories.

11. The Directors of the solar physics observatory at Kodaikanal and of the magnetic observatory near Bombay publish separate annual reports, to which reference may be made for accounts of their work.

The purely meteorological observatories under the department's care number 275, and include stations as far afield as Tehran, Kashgar, Aden and Seychelles. Their classification according to the frequency of the times of observation and to the number of elements observed was described in the 1918-19 report. While the maintenance of these observatories, the supply to them of tested instruments, and the careful scrutiny of their observations to detect mistakes naturally entail much work at headquarters, it seems unnecessary to deal with it in detail on account of its routine character. Some conception of the standard of accuracy maintained may be gathered from the number of mistakes detected in the data for the Indian Daily Weather Report. The stations of great reliability, in which at most one mistake has been detected, numbered 27, while the number, at which more than 50 mistakes were made, was 9.

Inspection of Observatories.

12. During the past six years the amount of inspection has fallen to about a third of the pre-war standard. We have not had gazetted officers to spare for occasional tours of inspection and the work has been left mainly to the Inspector of Observatories, Mr. P. K. Ghose. The latter inspected 25 observatories during the year, and Mr. V. Doraiswamy 6, while the Director-General inspected the observatories at Alipore, Agra, and Lahore. It will be necessary to arrange for more frequent inspections in future, if reliance is to be placed on the data, the provision of which is the sole object of the observatories.

Marine Meteorology.

13. The want of weather telegrams from ships at sea has always formed a difficulty in the determination of the movement and intensity of storms. Inferences had to be made from the coast observations only. To arrive at correct conclusions about storms in the Arabian Sea was especially difficult, as their movements had generally to be inferred solely from the observations received from the west coast of India, where moreover the Western Ghats have a disturbing effect upon the wind directions. Accordingly a system was organized in 1914 for collecting weather observations from ships by wireless telegraphy. Shortly afterwards this had to be closed down as ships were not permitted to send wireless messages during the war. In May 1920, shipping companies were again asked to co-operate in this matter and code books have since then been distributed to a large number of ships plying in Indian waters. Though the code explained that the ships' charges for these telegrams should be debited to this department, the question of payment seems to have been a stumbling-block to the masters of some ships. The Marconi Company were asked if they would allow weather messages to be transmitted free of ships' charges, a concession allowed to one or two other countries. They

have very kindly agreed to this proposal, which took effect from the 1st July 1921. The system promises by degrees to develop considerable value.

At Calcutta and Bombay a clerk at each port spends his whole time in visiting ships, making in each case a copy of the log and a comparison of the ship's barometer with a secondary standard, for the purpose of applying the necessary corrections to the readings in the logs ; and, after the barometer comparisons have been made, a statement of the error of the ships' barometer is given to the captain, in case he should desire to make use of it. The number of ships visited is materially less than that of the vessels which come into port, but it is ample for the purposes of the department.

The data thus obtained are utilised in the preparation of charts of disturbances in the Bay of Bengal and the Arabian Sea for future reference in connection with the storm warning work of the department, and in drawing up an account of the storms of the year for publication in the Annual Summary.

The arrangement made with Royal Alfred Observatory at Mauritius, for collecting marine data from the Indian Ocean, has been continued, and the thanks of this department are again due to that office for thus supplying a large amount of useful data. No such data were received from the London Meteorological Office during the year.

Snowfall Registration in the mountain districts to the north and west of India.

14. The information as to the amount, distribution and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete, and the thanks of the department are again due to the various officers who have collected and forwarded it.

Rainfall Registration.

15. The registration of rainfall in India has invariably been carried out by the provincial authorities. In 1889 a uniform system was introduced by the Government of India, and the Director-General of Observatories was made consulting officer in connection with this work. His advice is sought regarding the starting of new rain-gauge stations, and he receives annual reports from the local officers responsible for the registration of rainfall upon the efficiency of the work. A general account of the system, which came into operation in the year 1891-92, will be found on pages 5—8 of the Administration Report of the year 1889-90, and on pages 6 and 7 of the Administration Report for the year 1890-91.

The following is a statement of the number of rain-gauge stations from which data were received for publication in the Rainfall data of India at the end of the year :—

Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1921.	Province or Division.	Number of rain-gauges supplying returns for publication on 31st March 1921.
Burma	216	Baluchistan	86
Assam	125	Rajputana	182
Bengal	243	Bombay and Sind	289
Bihar and Orissa	306	Central India	126
United Provinces	274	Central Provinces and Berar ..	188
Punjab	192	Hyderabad	19
Kashmir	38	Mysore	77
North-West Frontier Province ..	32	Madras (including Pudukkottai, Coorg, Travancore and Cochin).	522

The system of rainfall registration cannot be maintained in a really efficient condition unless every provincial rain-gauge station is inspected at least once each year. Unfortunately only a few provinces have been able to state regularly in their annual reports that over 75 per cent. of their gauges have been inspected. Accordingly a letter asking for more frequent inspections was addressed in January last to most of the officers in charge of rainfall registration ; it was suggested that the district officers should be informed in January each year of the names of the stations which had not been inspected during the previous nine months and be asked to inspect as many of these as possible before 31st March. This method was adopted some years ago in the Madras Presidency, where, as a result, over 95 per cent. of the stations have been inspected annually. The reports below show a gratifying response to this letter, and a still greater improvement is likely to be shown next year.

The following paragraphs give a brief summary of the reports of the officers in charge of rainfall registration for the year 1920-21 :—

Assam.—The Director of the Department of Land Records and Agriculture reports :—" The number of inspections reported is 173 against 119 of last year and that of stations inspected 117 or 94 per cent. against 64 or 52 per cent. Only 8 stations against 60 of last year were not inspected. The inspection of rain-gauges has been satisfactory during the year in comparison with the previous years owing mainly to the introduction at the suggestion of the Director-General of Observatories, Calcutta, of a new method whereby the District Officers are informed in January of the names of the stations not inspected during the previous 9 months and requested to have as many of them as possible inspected before the end of March.

Baluchistan.—The number of stations that were inspected is not given in the report, but the Revenue Commissioner states that " The rain-gauges in the Agency were regularly read by persons in charge and inspected occasionally by various officers, to whom instructions were issued to state the number of stations inspected by them during the year."

Bihar and Orissa.—The Director of Agriculture states :—" During the year under report 210 stations were inspected while 248 inspection cards were received against 235 of last year. Action was taken to remove the defects disclosed by inspection cards and in one case the rain-gauge was moved to secure a satisfactory exposure. The rainfall registration work was generally done satisfactroily."

Bengal.—Of the 243 stations only 114 were inspected.

Bombay and Sind.—The Director of Agriculture reports :—" There was a considerable improvement over last year as regards the amount of inspection. Out of the total of 278 gauges in the Presidency, 226 or nearly 82 per cent. were inspected as against 191 of the last year ; 91 gauges were inspected more than once and the total number of inspections amounted to 334 as against 281 in the previous year. There was a considerable improvement in the inspection work in the Native States too. As many as 54 gauges out of a total of 61 or nearly 89 per cent. were inspected during the year as against 25 in the previous year. Only one gauge was inspected more than once and the total number of inspections amounted to 55."

Burma.—The Director of Agriculture reports :—" Of 216 stations 18 are meteorological observatories, 25 are in charge of the Public Works Department, 2 are under the control of the Agricultural Department and the rest are under the supervision of Civil Officers.

The total number of rain-gauges inspected during the year was 179, an increase of 42 as compared with that of last year. The inspections were satisfactory, the percentage being 82. Fifty-three rain-gauges in 19 districts were inspected twice by district officers. Of those inspected 145 were reported to be in good condition, and the remaining 34 were in a fair state. The chief defects were, as usual, the proximity of buildings and trees."

Central Provinces and Berar.—The number of inspections of rain-gauge stations in the Central Provinces was 202 against 179 in the preceding year and 148 in 1918-19. With regard to Berar, it is stated that the inspecting officers of Amraoti, Buldana and Yeotmal have not made a sufficient number of inspections. On the whole the standard of registration attained during the year may be described as fairly statisfactory.

Hyderabad.—The rainfall registering stations of Hyderabad are in charge of the Nizam's Public Works Department. There are 17 stations, of which only 6 were inspected during the year. In addition there is a rain-gauge in charge of the Residency Surgeon and one at Bolarum attached to the Indian Section Hospital.

Kashmir.—The Meteorological Reporter states that " Out of the total 39 stations, 8 are meteorological observatories and the remaining 31 are merely rain recording stations under the supervision of the Revenue Board. The number of inspections of the rain-gauge stations made

during the year was 8. Every effort is being made for inspection of these stations regularly and frequently and the Revenue Officers are being requested for the same."

Madras.—Out of 492 rain recording stations, 392 were in the Presidency, and of these the number inspected was 381 or 97 per cent. Of the 100 rain-gauges in the Native States 82 were inspected, as compared with 97 in the previous year.

Mysore.—Out of a total of 226 stations 180 or 80 per cent. were inspected during 1920 as against 94 per cent. in 1919.

North-West Frontier Province.—On the 24th June 1921, the Revenue Commissioner wrote as follows :—" Your letter regarding the necessity for inspecting all rain-gauge stations annually was sent to all distrcit fficers concerned with instructions to send me a special report this year on the extent and nature of rain-gauge inspections carried out, and also with effect from next year, to comment on this matter particularly in the annual Land Revenue Report. I have now received the special report from all Districts and Agencies. Of 36 stations, all but 9 were recently inspected. The majority are reported to be in good working order. I am instructing the officers concerned to inspect the rain-gauge stations not yet visited, as soon as possible and to see that they are being maintained in proper order."

Punjab.—Of the 241 rain-gauges about 150 are under the charge of district officers and the remainder under charge of irrigation officers. There were 87 inspections of the district rain-gauges.

United Provinces.—Out of 270 rain-gauge stations under the supervision of district and canal officers, 67 per cent. were inspected as compared with 49 per cent. in the previous year.

Summary.—In Assam, Burma, North-West Frontier Province, Bombay, Madras and Mysore, the proportion of the rainfall stations inspected was over 75 per cent. which is satisfactory. In Bihar and Orissa, the United Provinces, Punjab and Central Provinces, where between 50 and 75 per cent. of gauges were inspected, the efficiency of the system must suffer before long. But the proportions in the remaining provinces—Bengal 47 per cent., Hyderabad 35 per cent., Kashmir 26 per cent.—are such as to call for serious attention.

Seismograph Observations.

16. Seismological observations were recorded throughout the year by two Omori-Ewing seismographs at Simla and at Calcutta and one at Bombay ; by Milne seismographs at Kodaikanal and Colaba (Bombay) ; and by means of other self-registering instruments at the last named station. The data were transmitted to the Seismological Committee of the British Associatoin.

Time Signals.

17. The observatories at Madras, Calcutta and Bombay determine time from star observations and communicate it to the local ports by time-ball signals. The distribution of time over the country generally is made from the Madras Observatory by a signal transmitted daily at 16 hours over the Indian telegraph system.

In addition a wireless time signal for the use of ships is broadcasted twice daily at 7-30 and 19-30, G. M. T., from the Calcutta Radio station ; the signal is sent direct from the Alipore observatory by automatic apparatus. Up to the 31st October 1920 the times of transmission were 7-30 and 19-30 G. M. T., but at the request of the admiralty these times were altered to 1-30 and 13-30, G. M. T., from the 1st November 1920 in order to fit in with the hours of watch on ships which carry only one wireless operator. The Telegraph Department had under construction a similar apparatus, which is to be installed at the Bombay observatory for the transmission of wireless time-signals from the Bombay Radio station.

All the time work was performed statisfactorily during the year.

Publications.

18. There were no changes made, during the year in the form of the routine publications of the department, of which a description will be found in the departmental administration reports of 1907-08 and 1910-11. Publication of the Monthly Weather Review and of the Annual Summary, which had been stopped during the war, fell further into arrears on account of the labour troubles in the Government Press, Calcutta On the other hand, and in spite of the shortage of staff, satisfactory progress was made in the preparation of the manuscripts of these reviews.

The monthly and annual supplements to the Indian Daily Weather Report have been printed as usual, and supply the general need for prompt information.

As usual, the telegraphic weather summary was despatched to subscribers daily about noon and the weekly rainfall summary was supplied to the Gazette of India and to press correspondents in Simla.

The following memoirs of the Indian Meteorological Department were published during the year :—

Volume XXII, Part IV, on winds at ground level and above at nine stations in India, by Mr. J. H. Field, M.A.

Volume XXII, Part V, cloud observations made in India between 1877 and 1914, by W. A. Harwood, M.Sc.

Miscellaneous.

19 Five hundred and ninety-eight books and pamphlets, either purchased or presented by scientific bodies, were added to the library during the year, as against six hundred and fifteen in the year 1919-20.

Ten libraries, observatories or societies were added during the year to the list of institutions to which the publications of the Indian Meteorological Department are supplied, and four were removed ; the number on the list is now 382.

A beginning was made in the systematic cataloguing and classifying of the books and pamphlets in the library. Many libraries in India have adopted Dewey's Decimal System of classification and this seemed at first to be a strong argument for its adoption in this office also. An examination of its treatment of meteorological subjects, however, soon showed it to be quite unsuitable for the classification of our books and pamphlets. On the other hand a complete and fairly satisfactory schedule of classification of meteorological subjects was devised many years ago for the International Catalogue of Scientific Literature, and has been adopted by the Royal Meteorological Society. It seemed advisable, therefore, to follow this schedule in our library, especially as the International Catalogue and the Meteorological Society's Journal provide excellent guides to the librarian in the classification of old and current works, respectively, and make it unnecessary for him to make frequent reference to gazetted officers.

Both subject and author card catalogues are being prepared. The current books and pamphlets are classified on receipt and slow progress has been made with the cataloguing of the older works in the library. It is desirable that the librarian should have a temporary assistant until the catalogue is completed.

Concluding Remarks.

20. The Meteorological Department owes a large part of its usefulness to the sympathetic assistance it receives from outside departments. Civil Surgeons and other officers of Government departments, as unpaid superintendents of observatories and in other capacities, help in the meteorological work ; the Telegraph and Postal Departments assist in every way in the rapid transmission of meteorological information, at the same time that they allow their employés to act as observers. The Indo-European Telegraph Department, also, by giving free transit to the daily records of the Persian observatories, places a large amount of most useful information at the disposal of the Meteorological Department. Weekly telegrams were received from May to September from the Director of the Royal Alfred Observatory, Mauritius, as well as from the departmental observatories at Zanzibar and Seychelles. These telegrams gave valuable information of the weather conditions in the Indian Ocean and the department is indebted to the officers indicated for the punctual transmission of the information. Thanks are more specially due to the Director of the Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at the disposal of the Indian Meteorological Department.

The department is greatly indebted for important information about meteorological conditions prevailing before and during the south-west monsoon to the Controller, Physical Department, Cairo; the Directors of the Observatories at Buenos Ayres and Santiago; and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

SIMLA;

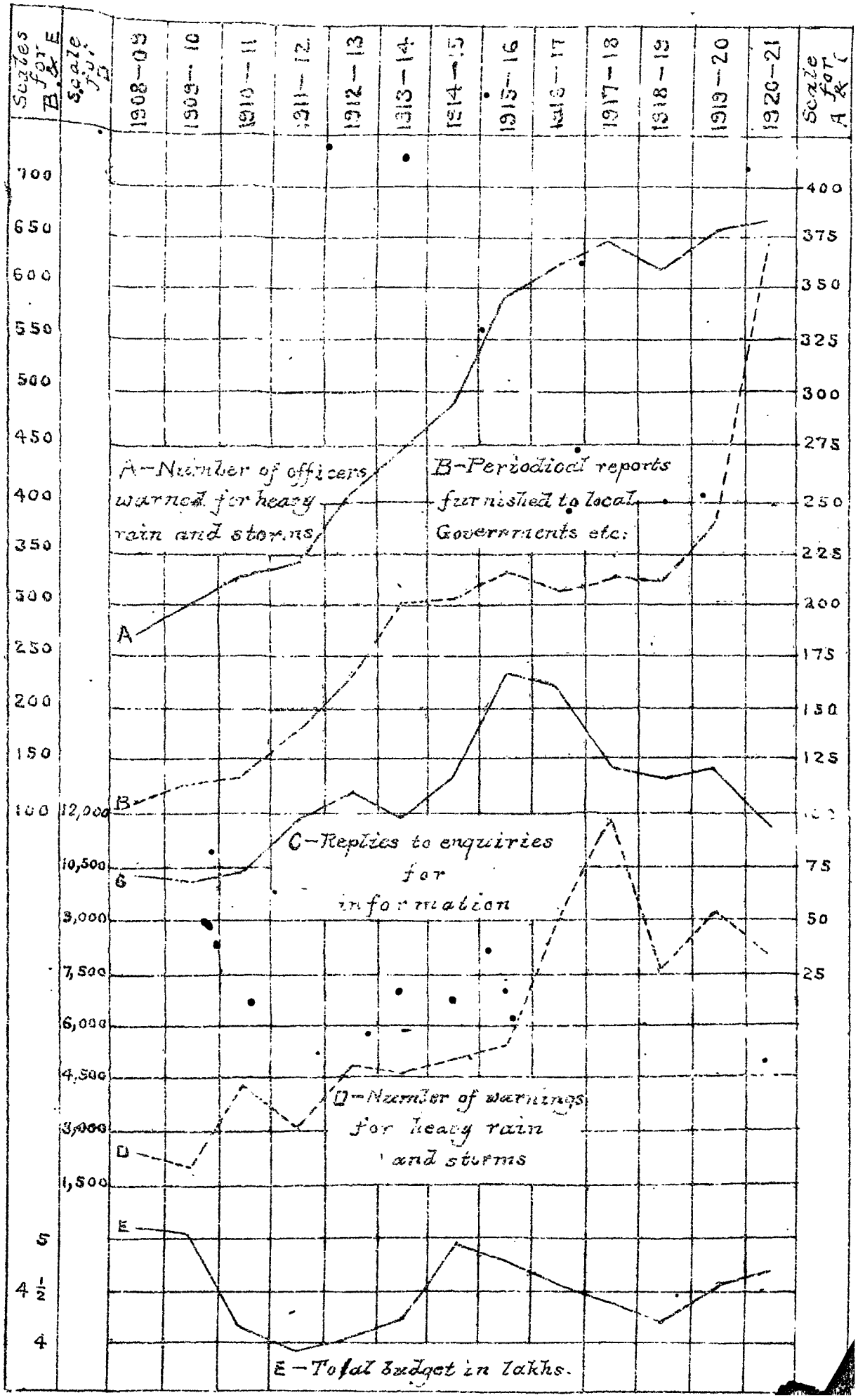
The 5th October 1921.

GILBERT T. WALKER,

Director General of Observatories.

G. M. Press, Simla.—No. 1DGofOb.—1-11-21—300 - P & S.

GROWTH IN DEPARTMENTAL ACTIVITY AND CHANGES IN TOTAL COST



00134425

Digitized with financial assistance from

Government of Maharashtra

on 01 February, 2020